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THE ROLE OF CLIMATE IN THE QUANTITATIVE AND QUALITATIVE CONTROL OF KARSTIC CORROSION

BY L. JAKUCS

In the classic period of karst-morphological researches, highlighted by the names of ECKERT, GRUND, CVIJIC, KREBS, KATZER, MARTEL, PENCK etc. and by a deductive analysis of the karstic phenomena and processes of the temperate zone, a synoptic approach to karsts was developed, an approach that generalized on a global scale the forms and contents of the system of karst categories characteristic of Central and Southern Europe. In other words, the geomorphologists of that time considered the characteristic features of the Dinaric Karst, of La Causses (France), etc. to be the morphological criteria of karsts in general, For this reason, any limestone area in which these features could not be indentified was not even considered a karst in most of the cases.

This principle is reflected by almost all karst definitions of the first half of this century and the approach of various authors to the problem is also basically brand-marked by this attitude. The geomorphologists recognized no qualitative but quantitative differences to be manifested in by the various climatic zones with regard to karstification. Hence, those early descriptions of totally different type, which reported on limestone denudations (e. g. DANES 1914, 1916. H. LEHMANN 1936, MEYERHOFF 1938, etc.), could enjoy a rather limited scope of interest and did not awaken any attention even though their authors may have spoken of karstification in these cases, too. Inspired in their developments by DOKUCHAEV's teachings, Soviet geomorphologists (MAKSIMOVICH 1947, APRODOV 1948, GVOZDETZKY 1947, 1950) were the first to emphasize that the notion of karstification should be widened on the basis of certain criteria of climatological zonring. Thus, besides normal karstification and associated classical karstic forms, they already distinguished the *thermokarst* (forst-induced karst) of the glacial belt and of the tundra areas and did describe both the processes of pseudokarstic mechanism and the resultant specific landforms. (For additional information, see BOC 1957.)

These studies were soon followed by pioneering publications evaluating the variety of specific *high altitude* karstic forms (RATHJENS 1951, 1954) and then, almost simultaneously with the Soviet developments, by H. LEHMANN's (1948) and BÜDEL's (1951) first works which, unlike their earlier publications, presented in the light of genetic classification the qualitatively quite peculiar morphological products of *tropical karstification.*

After that, in the 1950's and 1960's the number of studies on climatical karstic morphology by both Hungarian and foreign authors increased by leaps and bounds, and a considerable progress was made, above all, in the understanding of tropical karstic processes and phenomena. On one hand, papers of general character on phenomenological investigations were published, on the other hand, newer regional descriptions were produced.

Of the first group the works of H. LEHMANN (1954/1, 1956, 1960), WISSMANN (1954), KOSACK (1952), CORBEL (1954, 1955, 1959, 1961), SZABÓ (1957), GVOZDETZKI (1958), KLIMASZEVSKI (1958), BIROT (1959), RENAULT (1959), BÜDEL (1963) and SWEETING-GERSTENHAUER (1960) are most important, whereas of the regional landscape descriptions, which might be regarded as being of classical weight, the publications of H. LEHMANN (1954/2, 1955), CRAMER (1955), GLENNIE (1956), WISSMANN (1957), GVOZDETZKI (1958), KUKLA (1958), SAINT-OURS (1959), SUNARTADIRDJA-LEHMANN (1960), GERSTENHAUER (1960, 1966), WHITE (1962), SMITH (1963), DOUGLAS (1964), MAXIMOWITSCH (1964), VERSTAPPEN (1964), TSCHIKISCHEV (1965) and ROSE (1966) have to be quoted. As for the Hungarian authors, a few comparatively more important literary products of this kind have even be on critically reviewed by A. KÉZ (1959, 1960, 1963), and D. BALÁZS. Moreover, D. BALÁZS was in the lucky position that he could supplement the data known from literature sources with his local observations of his own.

However great number of works of general and regional object were published on the morphological effect of climatic changes on karstification, the lack of a uniform stand as to the differences in dynamism of karstification of different climatic zones is still obvious and the conception some authors have inherited from the classical karst-morphological school with regard to the interpretation of karstic corrosion mechanism is still confronted with irreconcilable contradictions when compared with the ever increasing multitude of observed facts.

In fact, according to the conventional model of the mechanism of karstic corrosion, as expounded in text-books, the CO_2-absorbing capacity of wated and, consequently, its corrosive power would be inversely proportional to temperature. Thus its dissolving power in polar and other cold regions (e. g. high mountains) would be higher than that of waters of higher temperature characteristic of the tropical zones. In reality, however, the karstic forms virtually observed in tropical karst areas are suggestive of denudation phases incomparably more advanced as compared to those occurring under cold climates, in almost all of the cases.

With the impressive results of J. CORBEL, the prominent French investigator of karsts, who published in a series of papers such information on the chemical composition of the waters of rivers draining karst areas of different climate which, beside being virtually observed and controllable facts, would readily contribute to the sharpening of the above contradiction it became particularly difficult to unravel the puzzle. Nota bene, CORBEL pointed out (1954, 1955, 1959) that the waters of rivers draining karstic surfaces of cold climate were carrying tenfold the amount of dissolved calcium carbonate transported by rivers originating in limestone areas of hot climate. From this observation, he drow the unambiguous conclusion that the rate of karstification in a cold zone is much more rapid than under a warm climate.

For a comparison of the rates of karstic denudation, he compared his regular, daily measurements in the rivers Kissimmee, Florida, USA, and *Tanana*, Alaska, USA, with data on river waters of other regions. His published results of these comparisons, which are selectively presented in Table I. have since become — we might say — classicál.

Table I

Quantitative characteristics of the karstic denudation of limestone surfaces according to J. CORBEL

Characteristics and location of investigated area	Rate of denudation $m^3/^3year/km^2$ or mm%-/year
Mountains with 2000 to 4000 mm of precipitation:	
a) cold belt: (Northern Norvey, Britisch Columbia)	450
b) warm belt: (Rio Usumacinta)	45
Low hills and plains with 1000 to 1600 mm of precipitation:	
a) cold belt: (Quebec, Western Shotland)	160
b) warm belt: (Rio Champotón Yucatan)	16
(KISSIMMEE, Florida)	5
Plains with 300 to 500 mm of precipitation:	
a) cold belt: (TANANA, Alaska) (Central Lapland)	40
b) warm belt: (Chélif, Orleansville)	4
Plains with less than 200 mm of precipitation:	
a) cold belt: (Lower reaches of the Mackenzie)	14
b) warm belt: (Rio Grande at Acacia)	1,4

With the knowledge of the chemical factors of limestone solubility in CO_2-containing water, however, it is aesy to realize that even though in case of the studied rivers of Florida and Alaska the figures calculated from observation data may apparently support CORBEL's suggestion, this approach to the problem has led to one of the most spectacular but false doctrines of geomorphology. This is a tragically typical example of how grave errors for science can ensue from a student's biased approach.

What should be noted in this connection is that in his basic assumptions CORBEL seems to have disregarded a few essential circumstances. Let us quote them herewith:

1. The carbonic acid content of water coming into contact with limestone is also controlled by factors other than the CO_2 contents and temperatures of meteoric waters and of the free air strata met with.

2. The role of the topmost soil layer of vegetation-clad karstic surfaces, layer containing decaying organic matter too, is much more important than that of the atmospherical CO_2 factor, as its soil „atmosphere" exposed to infiltrating water over a large area can have a CO_2 content several hundred times that of the free atmosphere (air).

3. Also, marked differences (even in order of magnitude) in the composition of soil atmosphere can be recognized when studied from the point of view of climatic zonality.

4. The CO_2 content of soil atmosphere may largely vary even within one and the same soil, a phenomenon for which the temperatures controlling the life rhythms of soil biotopes are primarily responsible.

5. According to investigations in France by TROMBE (1951/1—2, 1952), the rendzinas, which in summer have a CO_2 content as high as 10%, do not show in winter any carbon dioxide just like this component is virtually absent in the lean, vegetation-free soils of high-altitude mountains and polar to subpolar climatic zones.

6. In the humus-rich, rapidly maturing soils of high dynamism of the tropics the carbon dioxide regime is characterized by figures attaining the multiple of even the summer-time concentration levels of the soils of the temperate belt.

7. Limestone corrosion is not only due to the action of the carbonic acid of water; in fact, the other anorganic and organic acids and other compounds are also effective agents, their presence and activity being increased by heat and abundant moisture.

If J. CORBEL would have taken into consideration the above circumstances too, he would surely have formulated diametrically opposite statements as to the intensity of limestone corrosion in the different climatic zones, statements which would have been in accordance with both the up-to-date solubility theories and the inambiguous conclusions deduceable from the analyses of geographic forms. By the way, as would result from conclusions of this kind, tropical karstification must have a rate at least tenfold the figure of glacial karstification rather than just one tenth of it.

Would CORBEL ot mechanically and disregarding the other ecological circumstances — have considered the chemical compositions of river waters drained off from climatically different karsts, he must have realized that not even the data quoted by him did warrant *that* which the French student wished to prove with them. Namely, CORBEL totally disregarded the fact that even that fraction of precipitations is a limestone-dissolving agent which is finally re — absorbed from the soil by the plants and which then re — enters the atmosphere via evapotranspiration just like it is, say, that fraction which is lost to river recharge on account of direct soil transpiration and evaporation. This water fraction is the more considerable, the warmer and humid the climate is, for the value of the coefficient of runoff for any area is defined, beside relief and lithology, first of all by the climatic factors of the region.

CORBEL, himself, indicates that wheras out of the 450 mm amount of annual precipitation of the area drained by Tanana river in Alaska, 450 mm (!), i. e. 100%, was found to run off a year, of the 1200 mm of annual rainfall of the warm drainage area of Kissimmee river in Florida as little as 175 mm (i. e. 14.58% that is just one seventh of the annual rainfall in round figure) could travel down the river.

As shown by the French writer, the 14.58% runoff fraction of the rainfall carried away 5 m^3 of dissolved limestone a year from each km^2 area of the surface drained by the river. If, however, the total amount of the precipitations could flow down the channel of Kissimmee river too, this would mean that the amount of limestone waste would be as high as five times seven, i. e. 35 m^3, per year per km^2, a figure not so much different from that given for the drainage area of Tanana river — 39.9 m^3 per year per km^2. And yet, we have every right to make a calculation like this, unless we want to make ourselves believe CORBEL's naive argument (which the French writer did not formulate in strict terms, but which he still applied in his conception) that the $CaCO_3$-dissolving power of rainwater would be defined by the river-drianed percentage of rainfall.

Naturally, CORBEL's sophisticated theory has also other essential shortcomings. For instance, he does not take in to consideration that the carbonic acid reaction of $CaCO_3$ dissolution is expressed by a so-called reversible equation, in other words, that the equilibrium balance of the solution is very unstable being sensibly upset by any slight change in environmental conditions. Thus the water of a river affected by typical water-softening agents so eloquently illustrated by CORBEL himself/ would not remain hard even if it were fed by hardest possible karstic waters in the source area of the river. For CORBEL writes, himself, that „in the environs of the Kissimmee the grassland is enmeshed by open water tables and by a promiscuous network of tributaries and ox-bows and that the temperature of river water is very high. Its mean daily temperature does rarely drop below 20° C, being close to 30° C for 3 months".

All the above circumstances must result in a rapid evaporation of the CO_2 content of the water and its intensive softening during the precipitation of lime. In other words, under circumstances like these, the composition of river water does not give any valuable information about the rate of karstification in the remote parts of the drained area. It does particularly not in the tropics where the degree of carbonic acid agressivity of the infiltrated waters primarily responsible for $CaCO_3$ dissolution and, consequently, for the actual corrosion too, are controlled by a soil atmosphere of high partial CO_2 pressure, and where the amount of dissolved CO_2 in surface rivers is very limited because of most unfavourable conditions for gas absorption. Let us recall in this connection the following chemical regularity: the dissolved gas content of the waters is defined by the partial pressure and temperature conditions existing in both the zone of infiltration and the stretches of runoff, and the higher the temperature of the space of reaction, the sooner a diffusion-absorption equilibrium between environment and solution will be established for one and the same interface.

Otherwise, it is quite natural that the composition of brooks and other watercourses, originating in karsted, barren surfaces of polar regions or high mountains, shows hardly any difference from that of waters in fissures of limestone masses or getting exposed in springs. Nota bene, in these cases there is not practically any noteworthy difference in temperature or partial CO_2 pressure between the air spaces coming into contact with the zone of infiltration on one hand, and with the zone of linear drainage (stretch of runoff) on the other.

However, the grater the role of soil atmosphere and of its, mainly biogenic, CO_2 concentration in defining the chemical character of infiltrated meteoric waters, i. e. the warmer the climate, the sharper the difference between the percentage of dissolution and that of removal by running water, to the point that *the amount of river-transported calcium carbonate will be practically insignificant as compared to actual wearing away due to karstic denudation-circumstances mostly characteristic of present-day tropics.*

Our above dispute with CORBEL has now led us to the formulation of one of the most important axioms of climato-genetic karst morphology. Accordingly, *glacial karsts will develop into leached skeletal karsts, whereas the karsts of the tropical belt will be converted into massive karsts because the calcium carbonate masses dissolved in higher levels will reaccumulate in situ or in deeper levels,* where $CaCO_3$ is transported vertically, only for the most part or where lateral transport, if any is confined to isolated, local spaces.

This is the explanation for the absence of tufa accumulations in polar karst areas and this is why polar caves are poor in dripstones (TELL 1962, ROHDENBUR-MEYER 1963). On the other hand, this relationship also accounts for the extremely high rates of tufa accumulation, both on the surface and underground, and of stalactitization in tropical karst areas.

It stands to reason that the karstic phenomena of the temperate zones are intermediate, in both quantitative and qualitative differences, between their tropical and glacial counterparts both on account of their geographic situation and climatico-genetical conditions.

However, it is only with a precise knowledge of the complexity and controlling factors of the processes of corrosion that all the above may become logically understandable. Therefore it is quite natural that CORBEL, who had disregarded almost all virtual facts and agents, must have arrived at erroneous results.

That the present writer still has had to enter into details with his criticism of CORBEL's theory (which may have deserved a better lot) is basically due to the fact that his teachings have embarassed a number of outstanding, modern students of karstic phenomena. Nevertheless, CORBEL's investigations of climatic karst morphology have produced quite positive results as well. We mean here that the French worker has deeply astonished a number of research workers. These went then into defence and set to develop their „anti-CORBEL" which, of course, required to have hosts of new observed data.

The present writer is perhaps not wrong, if he supposes that a part of the valuable contributions to climatical karst morphology which appeared in the late 1950's and the 1960's and which have already been reviewed, were produced as a result of efforts made from these considerations. In Hungarian literature it is the paper of BALÁZS 1963 that provides a cross-section of the matter, though it appears that, as regards a virtually universal answer to the question, there is still a gap to be filled even in the international literature which is seemingly due to difficulties of data-collecting — a rather labourintensive and expensive work. Nota bene, CORBEL himself has collectend his 3000 (!) data of measuring of Tanana and Kissimmee rivers since 1930, so even in view of the mass of information available does it look appropriate to give an answer in which one is not obliged to relie merely on the „naked sword" of one's conviction of being right.

Even if the international scientific information of the last twenty years of climatico-morphological investigations of karsts were possibly insufficient for a spectacular disproval of CORBEL's teachings, it must be abundant enough to enable one to determine the *relative rate of karstic corrosion* and, more precisely, the *percentage ratios of the agents involved,* for each particular zone of the different characteristic climatogenetic facies of karst morphology.

The present writer should like to point out once more that he considers, himself, this experiment to be a first approximation which still needs closer scrutiny in many a detail. Further precision is expected to be provided by calculations and assessments by other authors as well as by potencial clarification of new aspects as a result of new information still unknown to the present writer. Still we hope that our calculations and conclusions may, in their basic trends, be devoid of such grave errors as the publication of these results as a basic of discussion ought to be feared.

Let us depart, first of all, of the fact that on the basis of the differences in the karstic dynamism of limestone corrosion the present writer would be able to discriminate five such distinct climatic zones which are though not correlable in some respects with the classical zones of climatical geomorphology (DOKUCAEV 1883, PENCK 1913, BÜDEL 1948, 1963, BULLA 1954/1—2, H. LEHMANN 1954/1, 1956, LOUIS 1964 etc.), but which can be readily distinguished from one another both quantitatively (rate of karstification) and qualitatively (variety of karstic forms), these differences being obviously of climatico-genetic nature. The following zones of this kind can be distinguished:

1. *High-altitude and periglacial zone* comprising the karsts of polar and subpolar regions, the tjäle and tundra belt as well as subnival reaches of high-altitude mountains.
2. *Temperate fluvial zone* inclusive of the zone of grasslands.
3. *Mediterranean zone* together with desert steppe areas.
4. *Zone of deserts.*
5. *Tropical karst-morphological province* considered here to include the savannah belt and the zone of subtropical monsoon rains, too.

It is a matter of course, that any of the above five groups could be further subdivided. With the present-day availability of information, it would not yet be justified to do so on account of the possibility of secessive assessment of the degree of karstic dynamics.

If the present writer wished to express in percentage values the relative rates of karstic corrosion for different climatical karst-morphological zones, so the results of his calculations, checked multilaterally, would lead him to the conclusion that *the ratio of the karstic dynamics of the zone of deserts corresponds, approximate by to 1%, that of the periglacial and high-altitude regions to 6%, that of the temperate zone 9%, that of the Mediterranean to 12%, while that of the tropical province to 72%.* In other words, the rate of tropical karstification is about 72 times that of karstification in deserts, sixfold the figure of the Mediterranean, eightfold that of the temperate zone and about twelve times that of high mountains. On the other hand, the Mediterranean karstic processes themselves attain about one and a half times the intensity characteristic of the temperate zone and twice that of the subnival and subpolar regions.

Even within these divergencies of the relative orders of magnitude of the rates of denudation, considerable differences are manifested with regard to the percentage shares of the various agents involved in corrosion, as illustrated numerically by Table II.

Table II

Percentage distribution of the genetic factors of karstic corrosion in the most typical zones of climatical karst morphology

(original). For explanation of numbers 1 to, 5 see Fig. 1.

	high-altitude + periglacial	temperate fluvial	mediterranean	desert	tropical
1=	45%	7%	4%	30%	0,5%
2=	5%	9%	8%	15%	2,5%
3=	30%	54%	55%	0%	50,0%
4=	5%	5%	8%	55%	4,0%
5=	15%	25%	25%	0%	43,0%

In Fig. 1. both the relative rates of karstic corrosion in the different climatical karst-morphological zones and the percentage distribution of the values of agents characteristic of the individual zones, have been shown combined. The figure readily demonstrates those substantial features which make it desirable to pay particular attention in these considerations to the qualitative specifics of the mechanism of dissolution which are at least as important and crucial as are the qualitative divergences of the dissolution processes of the individual climatic zones (Fig. 1.)

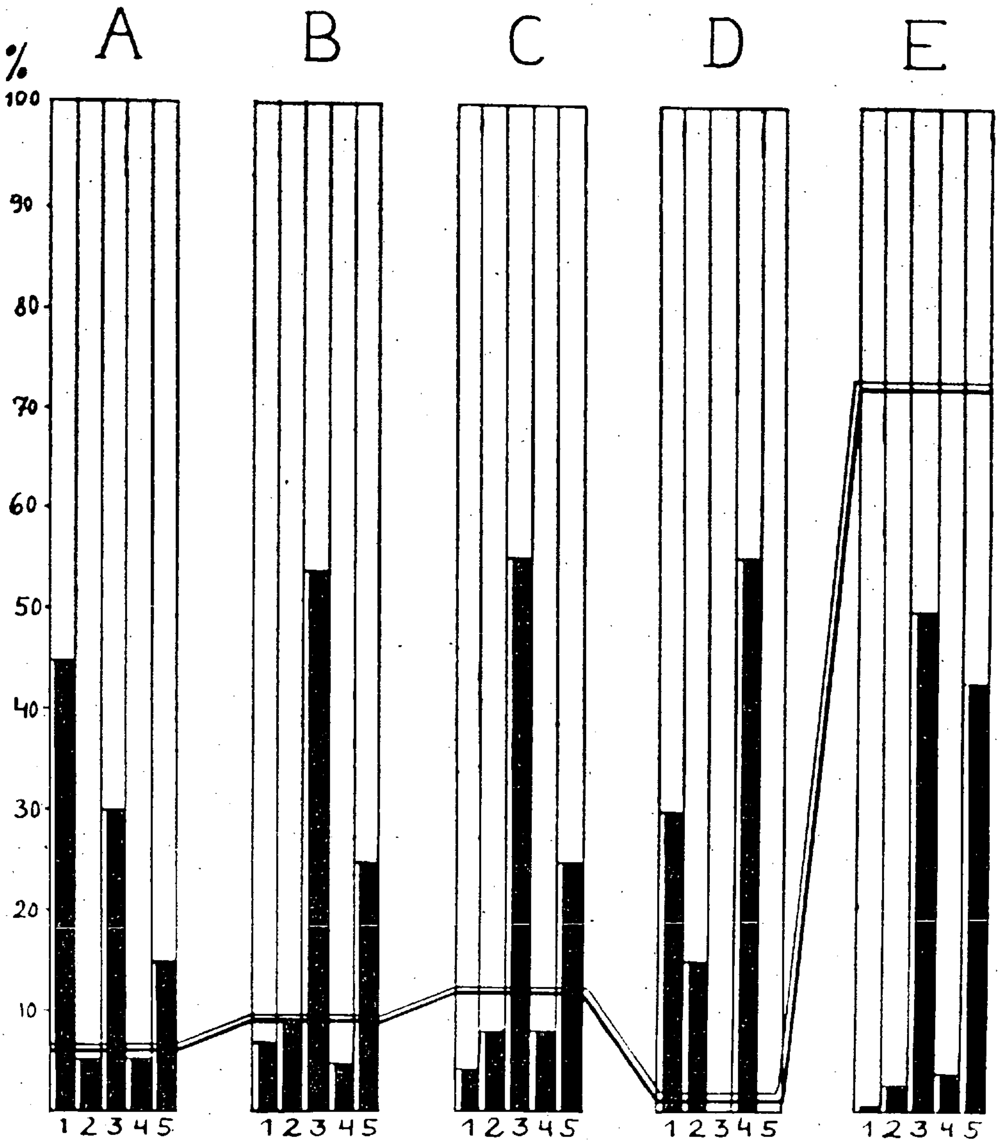

Fig. 1. Relative rates of karstic corrosion and percentage distribution of its agents in the most typical heteroclimatic zones of karst-morphological facies (original).

Explanations: relative percentage intensity level of the dynamism of corrosive karstic denudation in the different climatic zones

Column A = high-altitude and periglacial (6%),
Column B = temperate-fluvial (9%),
Column C = Mediterranean (12%),
Column D = desert (1%),
Column E = tropical karst-morphological province (72%)

Agents of karstic corrosion:

1 = CO_2 fraction of atmospherical origin,
2 = CO_2 deriving from inorganic soil processes (e. g. weathering),
3 = biogenic CO_2 in the soil,
4 = share of other inorganic acids,
5 = share of organic acids (humic acid, root fluids, etc.)

At closer scrutiny, however, Fig. 1. may also convince the reader, that the single diagrams constituing the columns A—B—C—D—E can be compared with one another within one and the same column only and that comparisons both diagrams of adjacent or farther columns must be confined to relative terms comparisons in absolute figures being impossible. For, in exact quantitative terms, a 50% share of the biogenic CO_2 factor in the tropical karsts accounting for 72% of total dynamics (i. e. characterized by extremely high rate of karstification) dinamics means substantially higher level of partial CO_2 than the same (50%) figure does for the temperate belt where the total intensity of corrosion is as low as 9%.

Therefore, to make the absolute values of the factorial agents of karstic corrosion commensurable, the present writer has calculated these quantitative values by examining how great is e. g. the actual quantitative share corresponding to the 45% ratio of atmospherical CO_2 in the periglacial zone. After that, the same was, successively calculated for another percentage value and so on. The method of these new calculations consisted in determining the 45 etc. % values corresponding to 6% characteristic of the periglacial zone and, naturally, the same method was used for the calculation of the values characteristic of the other climatic zones, too.

The resultant quantitative indices, which now can be really — and very instructively — compared both with one another and with other members of the same horizontal line, are shown in Table III. (In the last column of this table the sums of the quantitative values of the individual factors in the differenct climatic zones are given. Hence, this column is an expression of the global share in corrosion of the factor being considered.)

If on the bas is of Table II a complex diagram of the causal solubility factors of the different climatical facies is plotted, *the undistorted, virtual order of magnitude of the manifestations of these agents will be brought into relief* a result directly utilisable for the appreciation of karst-morphological problems (Fig. 2).

Table III.

Absolute values of the factorial agents of karstic corrosion in the most specific heteroclimatic zones as expressed by the ratios of the solubility levels characteristic of these zones (original). For explanations of numbers 1 to 5, see Fig. 1.

	high-altitude + periglacial	temperate fluvial	mediterranean	desert	tropical	global share of the factor in karst corrosion %
1=	2.70	0.63	0.48	0,30	0,36	4,47
2=	0,30	0,81	0,96	0,15	1,80	4,02
3=	1,80	4,86	6,60	0,00	36,00	49,26
4=	0,30	0,45	0,96	0,55	2,88	5,14
5=	0,90	2,25	3,00	0,00	30,96	37,11
Total:	6,00	9,00	12,00	1,00	72,00	100,00

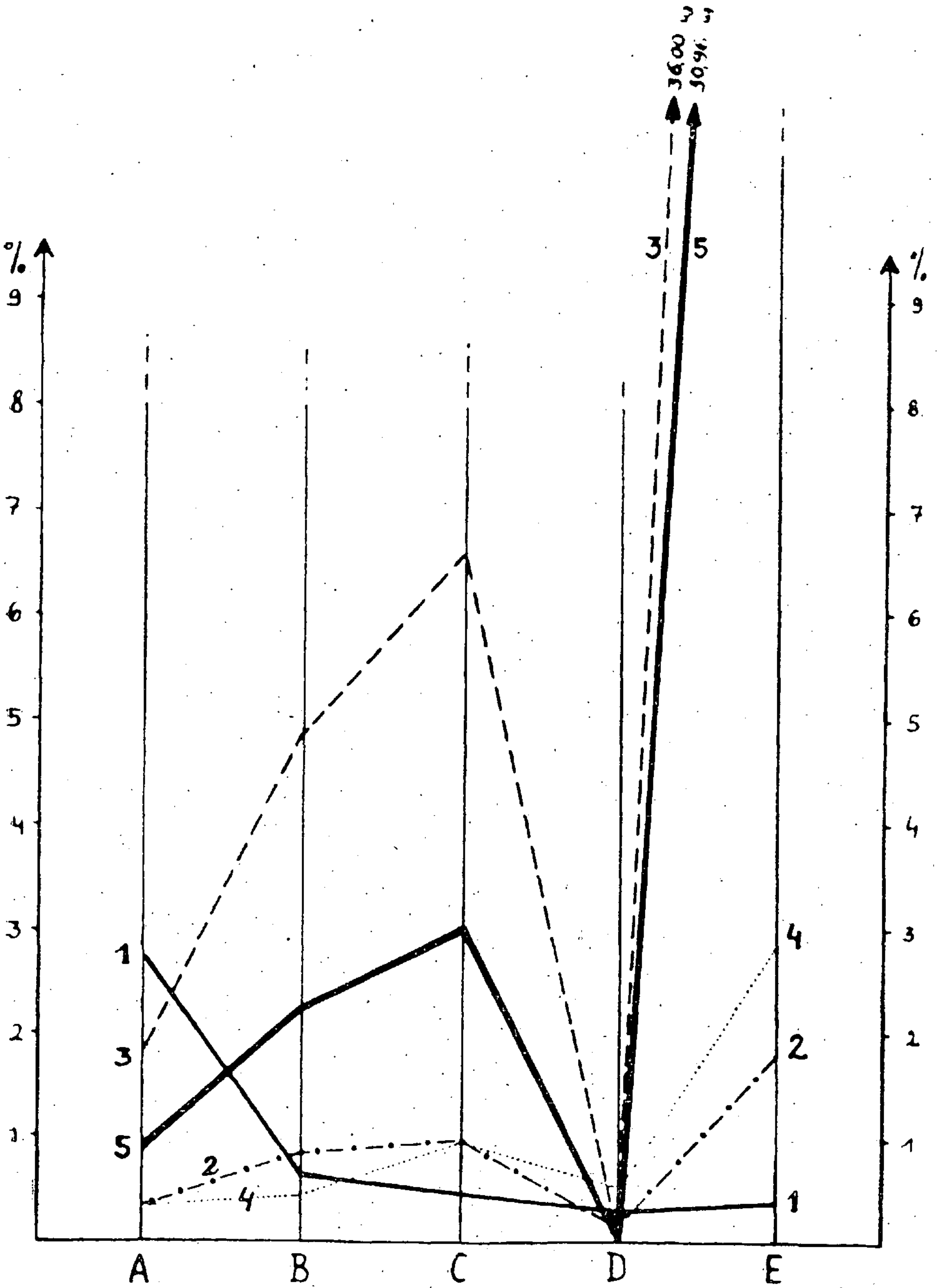

Fig. 2. Absolute values of the efficiency of the individual agents of karstic corrosion as found in the different climatic zones. For explanation of numerals and letter symbols, see Fig. 1. (Original.)

In Fig. 2 the individual curves themselves are very instructive, but a comparison of the various diagrams may also prouve rather impressive. Let us review now in a little fuller detail the objective trends reflected by this extremely important figure.

First of all, the secessiveness of the behaviour of atmospherical CO_2 (Curve 1), as compared to the curves representing the other corrosion factors, is obvious. Nota bene, whereas the lines of the other factors tend to rise markedly with the combined increase of temperature and rainfall, the line of atmospherical CO_2 shows, on the contrary, a trend of abating.

This abating trend is otherwise quite natural, for it reflects the validity for this case of HENRY-DALTON's gas absorption law, i. e. the fact that the amount of gas absorbed in cold water is higher than it is in warm one. (It is this law, and unfortunately just this one, that CORBEL referred to in formulating his ominous generalizations.)

The HENRY-DALTON law *in se* does, however, not account for the differences in orders of magnitude between the „stages" of the descendent line, for the difference in degrees centigrade between the thermal levels of climatic zones A and B is not so high as to account for a considerable drop of this kind. This holds particularly true when considering the farther stretches of the curve, where some substantial thermal level differences (e. g. between B and E) are though manifested but where these zones do still not differ so greatly from one another inasmuch as the corrosive action ot atmospherical CO_2 is concerned.

As for the cause ot the phenomenon, a possible explanation is certainly that, in A, much of water is precipitated (in form of snow or drizzle in other words, under conditions favourable for the absorption of gases) and that, once precipitated on the surface, the snow will remain in contact with the air for a long time. It is quite probable that this is practically the only climatic stable dissolution-precipitation zone where an equilibrium of calcium carbonate is established in the infiltration zone mainly in dependence on the partial pressure of atmospherical CO_2. Accordingly, the total amount of absorbed atmospherical CO_2 here is defined by both simple physical gas absorption and the need for gases of the chemical reaction of hydrocarbonate dissolution.

Even though not striking, but still quite easily recognizable is another interesting feature of Curve 1. This consists in that the total amount of water-dissolved CO_2 of atmospherical origin in E (in the tropics) is a little higher than it is in D. Since in E this cannot be due to a decrease in temperature, one cannot help thinking in interpreting the phenomenon, that one has to do with a kind of reflection of the higher general CO_2 level of tropical atmosphere.

All in all, and in comparison to the other solubility factors, however, atmospherical CO_2 must be declared to be a factor rather little involved in karstic corrosion in all but the *high-altitude and periglacial (subpolar) climatic zones and that it is particularly in the tropical belt that its presence and action can be totally neglected in the background of other corrosion agents several times more efficient.* (For instance, the effeciency of biogenic CO_2 is exactly 100 times that of atmospherical CO_2!)

Out of the additional diagrams of Fig. 2, the lines of No 2 and No 4 CO_2 produced by inorganic soil processes and other inorganic compounds (mainly acids) testify to the fact that these factors show but a very low, and relatively subequal, rate of increase with the combined growth of poth temperature and humidity. This is a matter of course, since any higher temperature usually enhances inorganic weathering reactions and since moisture, the carrier of ionic reactions in the soil, renders all this possible. This is why the efficiency of these two factors in tropical limestone dissolution is, as a rule, twice to tenfold the figure characteristic of the other climatic zones, being under all climates except the polar belt, usually a little higher than that of atmospherical CO_2. And yet they have shared comparatively little in the dynamics of corrosion.

It seems to be proper to point out here already, that in climatic zone D (desert) almost all corrosion factors are characterized by a very reduced rate of action. This is due solely to the lack of water so that the action of biogenic agents is radically cancelled and even the other chemical processes are heavily handicapped. So it is essentially the poor CO_2, deriving from the air for the most part and transmitted mainly by dewfall, and the low-rate mineralogical reactions of „desert weathering" that are manifested, but their products, if any, are difficult to assess.

The behaviour of Curves 3 and 5 may look rather surprising. As pointed out above, these diagrams are expressions of the shares of the biogenic CO_2 and the organic acids of the soil as involved in karstic corrosion. As evidenced convincingly by the curves, *both the factors are excessively sensitive to climate, being the essential agents of karstic corrosion over the major part of Earth's surface.* Even in the mostly barren karst areas of cold climate category A, their role is of great importance, being readily manifested with the appearance of lichen over the smallest rock surfaces or with the poorest possible soil bacterial action. In temperate and Mediterranean karstic processes, however, they become crucial corrosive agents. The higher the compactness of the biosphere of earth's surface (particularly so, of its vegetation) and the less its seasonal biological cyclicity, if any, the more progressive the growth of their efficiency. So in the tropics it is merely factors 3 and 5 that are responsible for the modelling of any karstic landscape.

By the way, the wealth of information published in international literature on geomorphology shows unambiguously, that in the tropics these two last-discussed corrosive agents (biogenic CO_2 organic soil acids) may gain overhand with respect to the rest of the morphogenetic agents (e. g. linear erosion, sheetwash, derasion, etc.) not only in limestone-built areas, but in areas made up of other rocks as well. Thus in zones of this kind even polymineralic sectors (e. g. areas made up of granites, andesites, etc.) may often happen to exhibit macro- and microforms (e. g. bell-shaped mounts, pinnacles, karrs, etc.) suggesting corrosive denudational processes.

An examination of Curves 3 and 5 in Fig. 2 may shed light upon

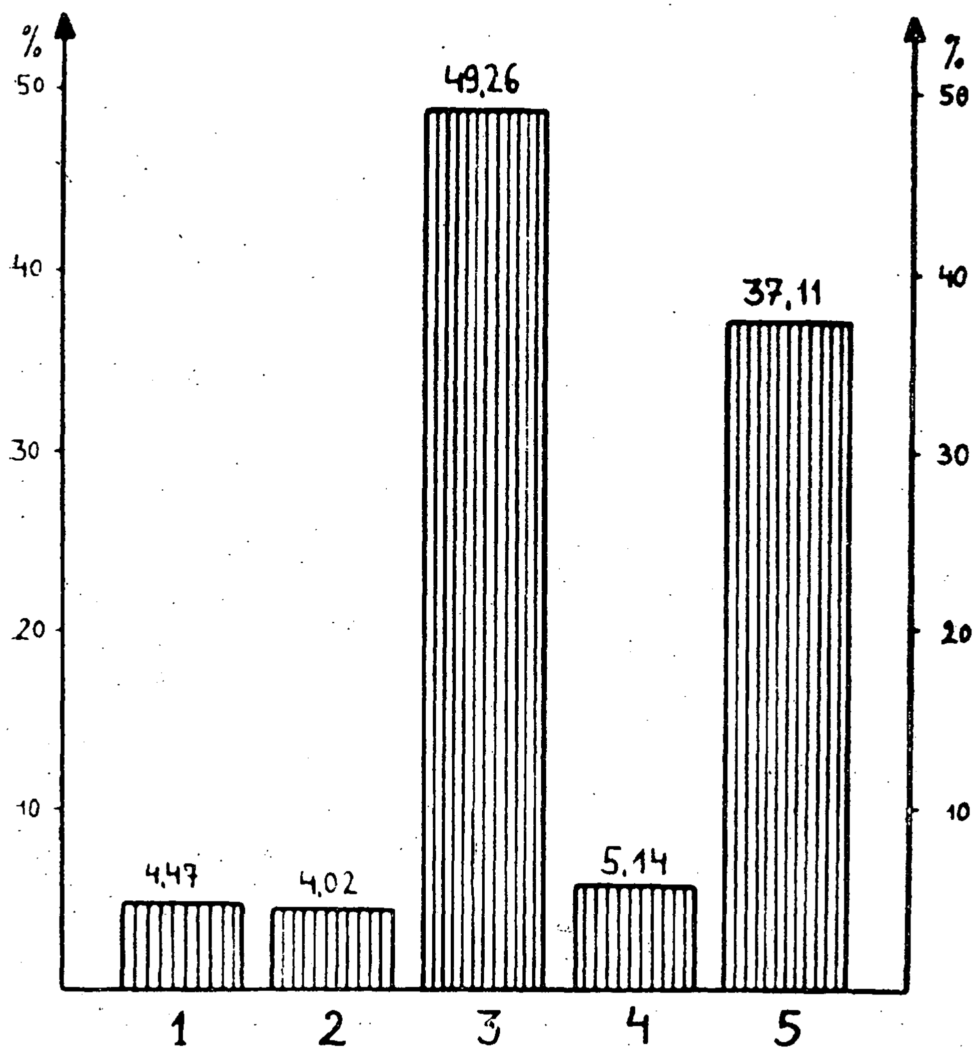

Fig. 3. Distribution of the main corrosive agents as reflected by the karstic denudation of calcareous rocks on the global (planetary) scale (original). For explanation of column numbers 1 to 5, see Fig. 1.

another interesting realtionship. Nota bene, if the A—C stretches of the curves are compared with one another, it appears that the increase of biogenic CO_2 towards C is more progressive than it is the case with organic soil acids. In E, however, this initial realtive tendency of the two factors is rather eliminated, as compared to their absolute height levels 36.00 and 30.96, respectively. In other words, whereas in the Mediterranean zone for instance the corrosive efficiency of biogenic carbonic acid attains more than twice the figure of organic acids, under tropical climate this ratio tends to become an equation as one proceeds towards higher altitudes.

While exploring the causes of the phenomenon, one may have the impression as if the accumulation of biogenic CO_2 in the soil had a maximum level which the corrosive action of organic acids can even keep pace with under favourable conditions but which does not keep on increasing obviously because, one one hand, it is jeopardized by soil transpiration itself, on the other hand, because too high a concentration of CO_2 is a drawback to the living conditions of the soil biotope itself (for it may stop the gas-producing biogenic processes themselves). It is still very difficult, however, to formulate this theory in strict terms, for no direct investigations into this problem have sor far been undertaken under tropical climates. Thus it is quite possible that expedient investigations of coming years may bring into relief another aspect of the relationship.

To make clear the absolute global (planetary) values of the limestone-eroding efficiency of the main agents of karstic corrosion, the present writer has also plotted in Fig. 3 the numerical data of the outside right vertical column of Table III.

In the light of the evidence provided by figure, we need not worry about formulating the most important result of the present writer's investigations. Accordingly, *the natural karstic corrosion of calcareous rocks is geneticaly nothing else than the phenomena of the biological and chemical evolution of the rock-covering topsoil as reflected by the soluble bedrock.*

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GEOCHRONOLOGY AND GEOMORPHOLOGY OF THE KÖRÖS—MAROS INTERFLUVE PLAIN

BY M. ANDÓ

The plain surrounded by the rivers Maros, Tisza and Körös is a geomorphological region of 5000 km_2 area. Compared to the adjacent physico-geographical regions, it can be considered a „ridge". Therefore its other name, „Békés-Csanád Ridge", is also appropriate. Its present-day morphological pattern is the result of the accumulative action of the paleo-Maros. Nota bene, it is for the most part a fluviatile alluvial fan, the Maros alluvial Fan, that occupies the territory. In some places, its boundary can be drawn merely on the basis of convention (Fig. 1).

1. From the point of view of subsurface geology, the region represents a Neogene basin underlain by a Mesozoic basement. One of the Great Hungarian Plain's depressions, it was brought about as a result of the subsidence of the basement and of subsequent filling up. As shown by the ever growing information of wildcats for hydrocarbons, the basement relief is an outpost of the Apuseni inselbergs, Rumania, with the highest subsurface elevation at Battonya along the Battonya—Orosháza axis. This is surrounded by a wide, arched, deep trough which can be split up into a wider and flatter northern and a narrower, deeper western basin portion (J. SÜMEGHY, 1944, L. KÖRÖSSY 1967, V. DANK 1966, M. ANDÓ—L. JAKUCS 1967; Fig. 2).

Of course, the basin bottom is divided into additional, minor structural units. For instance, the basement surface is also likely to be patterned by minor depressions, crests, saddles, horsts, etc.

Pannonian subsidence led to the accumulation of about 1500 to 2000 m of marine sediment (Fig. 3). The Upper Pannonian sequence is constituted by highly calcareous clays, well stratified for the most part, the Lower Pannonian being, however, represented by another facies-grey clay-marls including sandstone layers. Both the stages were produced by marine sedimentation. The occasionally coarser-grained sediments of the Lower Pannonian are indicative of the high rate of subsidence as well as of a very strong abrasion of the coastal environment (J. SÜMEGHY 1944).

In the Levantine beds a marked coarsening of the sediment can be observed. In comparison to the Pannonian beds, these form structurally more differentiated depressions. The sediments in these are usually more porous and less consolidated, being characterized by frequent changes in the mode of occurrence and by the predominance of sands. Moreover, in

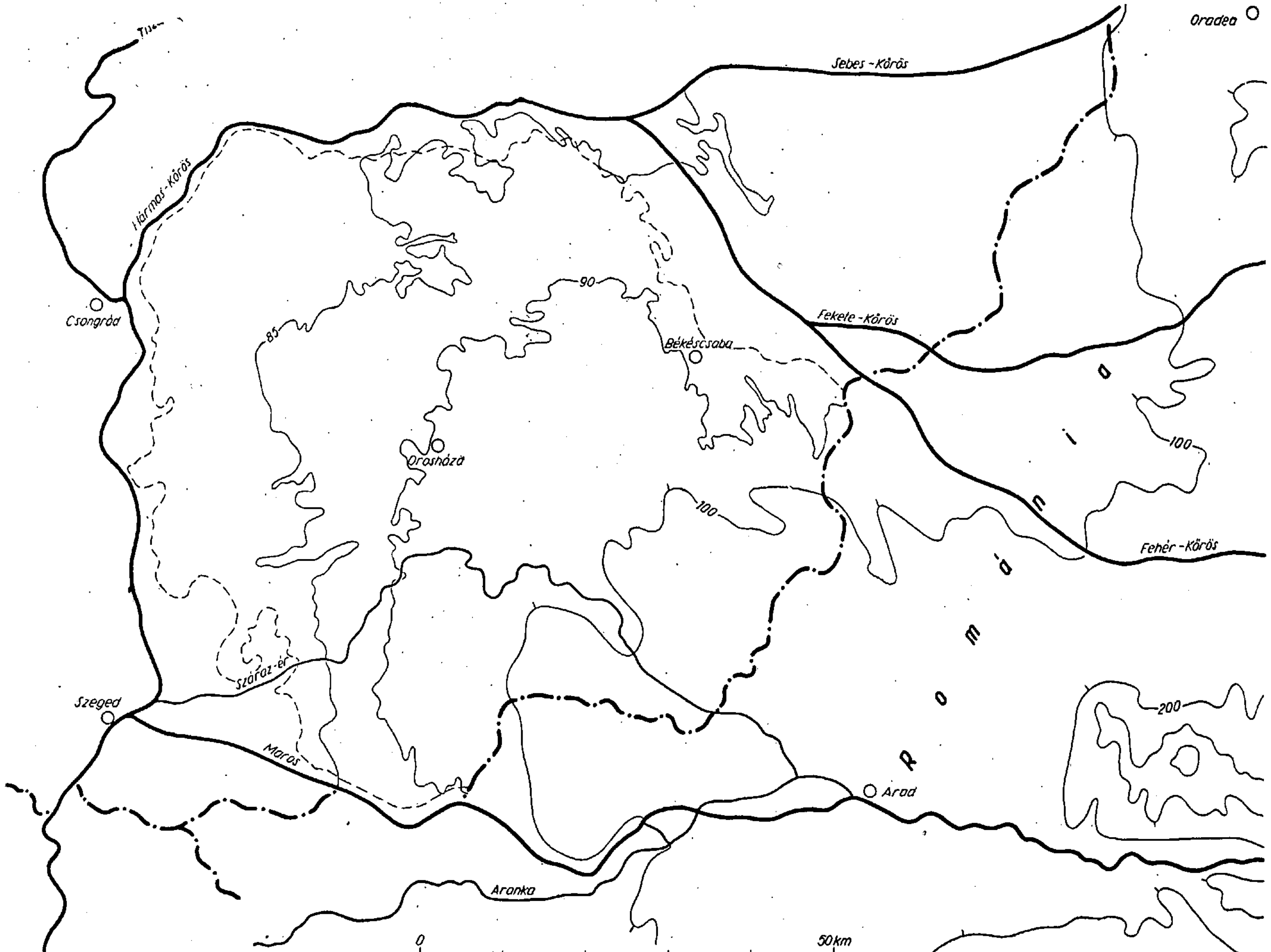


Fig. 1. Sketch of the Körös—Maros Interfluve Plain and its mountainous foreland.

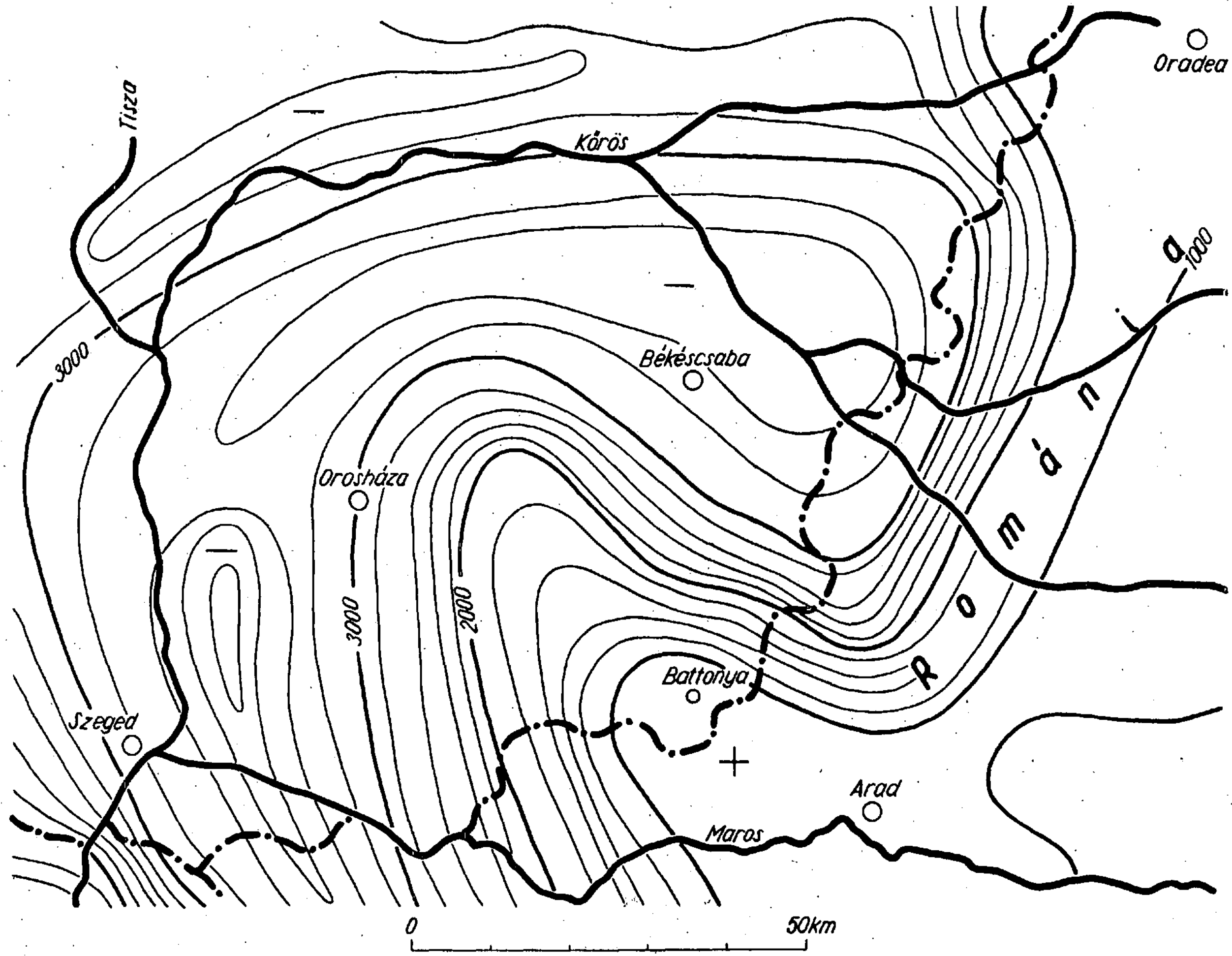


Fig. 2. Contour map of the pre-Tertiary basement (courtesy of V. Dank).

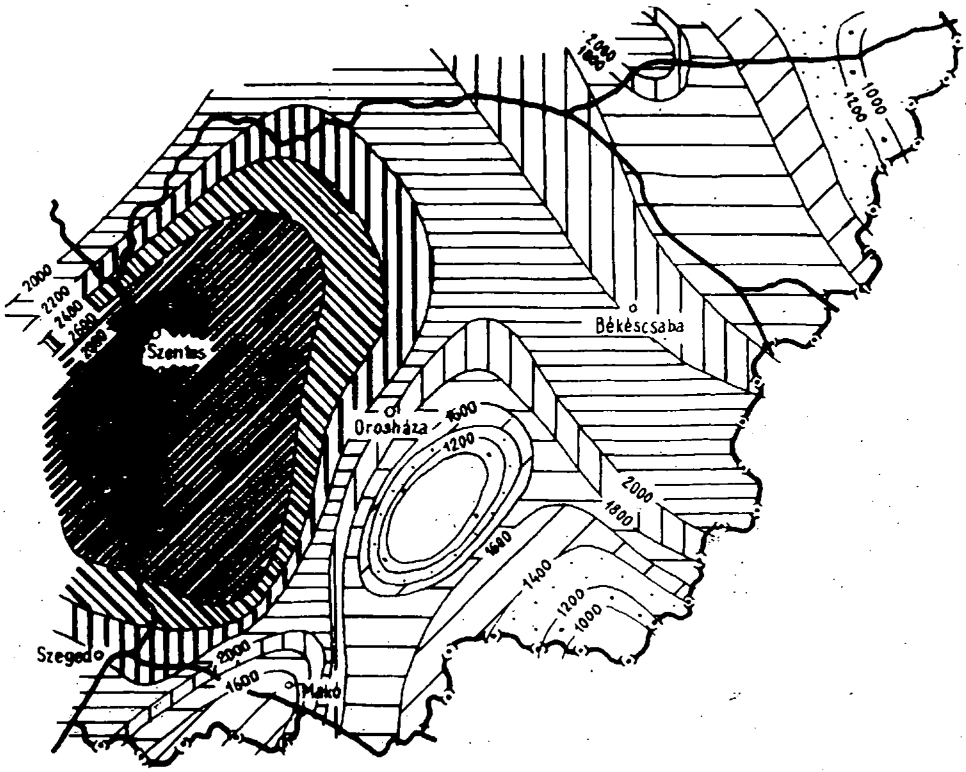


Fig. 3. Isopatch map of the Pannonian sequence of the southern Tiszántúl (territory east of the Tisza) (courtesy of E. R. Schmidt and G. Láng).

the foreland of the Apuseni inselbersg, the upper levels include some gravels, too (J. SÜMEGHY 1944, J. URBANCSEK, 1961, M. ANDÓ 1964). The gradually increasing ratio of sands and gravels as well as the lack of clay layers over much of the territory indicates that in Levantine time the territory subsided very rapidly and that the coarse sediment was transported by rivers.

2. The morphological evolution of the territory in the Pleistocene was connected for the most part with fluvial accumulation, even though lacustrine sediments were deposited at a considerable rate. The peak of the Maros Alluvial Fan of about 80 to 100 km radius is at Radna, at a height of about 130 m. Its marginal outcrop is 85 m high a. s. l. at Makó, 83 m at Hódmezővásárhely, 90 m at Orosháza, and 90 m in the vicinity of Békéscsaba. It is constituted for the most part by medium to coarse sands, sandy gravels and gravels. As shown by water-prospecting drilling, the fluviatile gravels occur, as a rule, down to 200 m depth with occasional occurrences at 500 m.

The coarse-grained sequence of the alluvial fan includes clay layers growing thicker from the ESE towards WNW. Whereas in the ESE the thickness of the gravels is 8 to 10 m, in the WNW it is as low as one-two m or so. The coarse-grained sediments are excellent aquifers.

Evidencing the work of the paleostream, the gravel deposits form three successive levels produced by three distinct stages in the evolution of the Fan. These gravel accumulation stages coincide with the rapid subsidence of the territory of the Fan and with the relative upheaval of the mountainous background. The alternation of coarse-and fine-fraction facies suggest, above all, intensive tectonic movement, climatic implications being of secondary importance. In the case of the territory under consideration, the increase in the slope of river bed due to the sinking of the base level enhanced the working capacity of the river and/or led to a change in its erosion-accumulation balance. On account of the resultant new conditions, with progressing accumulation, the pre-subsidence pattern of the relief was re-established, a fact evidenced by the decrease in the grain size of the transported detrital material, i. e. in the refinement of the sediment. Consequently, the above-quoted gravel-accumulation stages are separated by sediments becoming gradually finer upwards and ending with silts at the topmost level.

Gravels can be encountered in the upper horizons of the Levantine stage, too. This is an indication of the onset of fluvial accumulation. Gravel layers are known to occur in boreholes at 570 m (Kunágota), 320—326 m (Bánkút) and 320—322 m (Orosháza). This coarse sediment is overlain (following a stage of refinement) by a coarse, gravel sequence (Lower Pleistocene) which in the aforementioned boreholes was observed at 257 m (Kunágota), 200 m (Bánkút) and 175 m (Orosháza), respectively (Sümeghy 1944). As will be shown hereafter too, during the Pleistocene the accumulations of gravels was repeated several times, but the marrow of the alluvial fan as well as the most extensive alluvial fan form is represented by the sequences of the above two gravel accumulation stages. The formation of the third stage can be ascribed to the Lower/Middle Pleistocene boundary already. On the basis of water-prospecting drilling, this horizon could be identified at 180 m (Lőkösháza), 116 m (Bánkút), 170 m (Földeák), 120 m (Bánhegyes), respectively. The above three gravel horizons (between 300 and 570 m, 200 and 260 m, 100 and 180 m) prove the rhythmical, intensive subsidence of the Fan's area in Early Pleistocene time.

The uppermost 100 m are made up of gravels mixed with sands, showing a gradual decrease in grain size and gradually thinner stratification upwards. This sequence falls short of the older ones both with regard to thickness and to lateral extension. The alternation of different layers and the radius of the Fan are reduced, while the finer-grained sand facies gains predominance. An examination of this sand material allows its student to reconstruct the paleogeographic pattern of the territory. The main channel of the paleo-Maros can be traced, unlike the present-day one, in the vicinity of Lőkösháza—Battonya villages. The main stream and its tributaries flowed that time still northwestwards, towards the angle of the rivers Tisza und Körös and accumulated their sediments along this line. This statement is readily substantiated by Tab-

Table 1.

(Courtesy of B. Molnár)

Localyti	Grain size (mm)	Predominant magmatic minerals									
		Nypersthene	Other rhombical	Monoclinal pyroxene	Diopside	Green amphibole	Magnetite Ilmenite	Biotite	Apatite	Titanite	Zircon
1. (Lőkösháza)	0,06—0,1	12,9	2,2	18,3	2,2	6,7	25,0	1,8	1,3	1,3	0,5
	0,1—0,2	18,2	0,9	14,1	0,3	4,6	20,0	2,8	0,9	0,9	0,3
	0,2—0,32	12,1	0,4	18,5	1,9	2,3	15,4	1,5	0,4	—	—
	0,32—0,63	11,2	—	18,6	1,2	2,3	17,1	1,9	—	—	—
2. (Apátfalva)	0,1—0,2	16,2	2,3	14,8	1,6	5,2	15,7	1,3	1,6	0,3	—
	0,2—0,32	15,9	1,2	18,9	0,4	3,7	12,2	0,4	1,2	—	—
	0,32—0,63	6,9	0,5	11,2	—	0,5	16,5	3,2	—	—	—
3. (Deszk)	0,06—0,1	12,9	3,7	10,2	4,1	3,4	22,9	1,4	3,1	0,7	—
	0,1—0,2	17,8	1,5	15,2	1,9	4,5	15,1	3,4	0,4	—	—
	0,2—0,32	18,8	3,0	24,0	1,7	3,0	10,9	—	0,4	—	—
	0,32—0,63	2,7	1,4	12,9	0,7	1,4	25,2	2,0	—	—	—
4. (Deszk)	0,06—0,1	12,1	3,3	15,2	4,2	5,1	16,2	0,5	2,8	0,5	—
	0,1—0,2	10,1	1,6	17,0	3,6	11,7	8,9	3,2	1,6	0,8	—
	0,2—0,32	2,9	0,4	7,8	0,8	4,5	14,3	11,1	—	—	—
	0,32—0,63	1,6	—	3,1	1,6	1,6	7,8	32,8	—	—	—

Table 2.

(Courtesy of B. Molnár)

Locality	Grain size (mm)	Predominant metamorphic minerals								Other minerals				Diametre in mm
		Chlorite	Tourmaline	Zoisite	Rutile	Bluishgreen amphibole	Actinolite, tremolite	Garnet	Staurolite	Distrhene	Calcite, Dolomite	Limonite	Weathered mineral	
1. (Lőkösháza)	0,06—0,1	7,6	0,5	—	—	6,7	—	7,6	0,5	—	—	1,3	3,6	
	0,1—0,2	9,8	—	0,3	0,6	5,5	0,6	10,7	0,6	0,3	—	0,3	8,3	
	0,2—0,32	12,5	—	—	—	6,8	0,4	7,6	1,1	2,3	0,8	0,8	15,2	2,5
	0,32—0,63	10,1	0,4	—	—	1,9	—	11,2	0,4	0,4	1,6	—	21,7	
2. (Apátfalva)	0,1—0,2	7,2	—	—	—	9,2	0,3	14,1	—	0,3	3,0	0,3	6,6	
	0,2—0,32	5,7	—	—	—	5,7	—	16,3	—	1,6	2,9	0,4	13,5	
	0,32—0,63	30,9	—	—	—	2,1	—	9,6	—	1,1	0,5	—	17,0	0,92
3. (Deszk)	0,06—0,1	0,7	0,7	0,3	0,7	7,1	2,0	18,0	0,3	—	0,3	1,4	6,1	
	0,1—0,2	4,9	0,8	0,4	0,4	10,2	0,8	13,6	0,4	0,8	—	—	7,9	
	0,2—0,32	3,0	—	0,4	0,4	8,3	—	8,3	0,4	0,4	0,4	0,4	16,2	0,45
	0,32—0,63	19,7	—	—	—	2,0	—	—	—	0,7	—	2,7	28,6	
4. (Deszk)	0,06—0,1	0,5	1,4	0,9	0,5	7,4	1,9	15,3	0,5	—	0,5	2,8	8,4	
	0,1—0,2	8,5	0,4	—	—	9,3	2,4	2,8	0,4	0,4	1,2	0,8	15,3	
	0,2—0,32	15,2	—	—	0,4	6,1	0,4	0,4	—	—	0,4	2,0	33,30	0,18
	0,32—0,63	42,1	—	—	—	3,9	0,8	0,8	—	—	—	—	3,9	

Table 3.

Chemical composition of sand samples from the Maros—Körös Interfluve (Courtesy of I. Mihàltz)

	Locality	SiO_2	Fe_2O_3	Al_2O_3	Total	Acid reaction	Mean grain diametre D 50 (mm)	Total heavy minerals weight %	128—250 mm heavy min. %	Magnetite of the same size range %
1.	*Orosháza* municipal sand pit	83.0	7.6	8.2	99'0	+ +	0.21	3.4	3.3	16.7
2.	*Orosháza* Sand pit of „Vörös Cs" co-operative fram	82,3	5,9	8,1	96,3	(+)	0,28	1,8	3,5	7,6
3.	*Orosháza* abandoned brickyard	76,6	9,0	10,2	95,8	(+)	0,22	3,5	5,1	11,7
4.	*Orosháza* lower railway station	79,3	9,5	6,4	95,2	+ +	0,25	3,1	4,1	9,9
5.	*Orosháza* upper railway station	76,2	6,1	7,7	90,0	+ +	0,17	3,8	4,8	7,5
6.	*Medgyesegyháza* Gyulai street	77,0	4,4	5,7	87,0	+	0,28	2,6	5,5	3,3
7.	*Apátfalva* between the Maros' levees	86,6	3,6	5,0	95,2	–	0,50	1,2	13,4	12,7
8.	*Deszk* Maros bank	78,0	7,8	5,9	91,7	–	0,15	4,2	1,5	6,0

les 1, 2, 3. It can be observed that the results of testing of samples taken along the Lőkösháza—Apátfalva line agree with the analyses of recent alluvial material from Deszk. The diverting of the Maros into its present-day bed has not been tectonically controlled, being the result of a gradual filling up of the paleochannel. With the filling up of the main channel the river migrated southwards to newer and newer channels until it has occupied its present-day bed. Left behind, its secondary channels got into a „hanging" position and died away, having been filled up by fine-grained sediment.

3. Involved in the constitution of geomorphological forms, the near-surface sediments are of fluviatile origin for a considerable part, though secondary accumulation by wind action has also been manifested.

Sands are one of the important near-surface sediments of the territory. They are represented by comparatively thicker near-surface accumulations in the higher parts of the Fan, being deeper-seated and thinner in the level areas. This pattern, however, is characteristic but in rough lines, so that no strict regularity can be spoken of.

On the basis of the analysis and comparative evaluation of bore samples and granulometric curves, respectively, it can be concluded that the abundances of the more sandy, coarser-grained sequences shows a direct relationship with the elevation above sea level of the territory. This relationship, however, can be regarded to be valid only statistically, since sandy facies occur in lower positions, too, even though these are linear and finer-grained for the most part. The above relationship is expressed by the following figure illustrating the character of strata arrangement and the relationships of the hypsometric elevations of the relief (Fig. 4).

It should be borne in mind, of course, that whereas the determined hypsometric levels show a large areal coverage, the associated frequency occurrences of sandy sequences remain linear, being manifested by linear statistics alone. Therefore, the boreholes and the associated morphometric evaluations allow one to draw up a true picture of the individual stages of paleogeographic evolution. The near-surface sands were deflated occasionally from dry channel stretches and then supplemented with redeposited (secondary) sand accumulations. Conclusions as to this process can be drawn from the degree of attrition of the grains. This is characteristic of the flanks of the Fan. In its southeastern part, however, only fluviatile, gravely coarse sands as well as medium to fine sands occur.

Clay has been largely involved in the constitution of the surface (Fig. 5). Near-surface clay layers play an important role in the kinetics of groundwaters (the uppermost subsurface water level), the deeper-seated clays do so in that of the aquifers. There occur silty, fine-sandy clays, but clays with traces of peat and humus are also common. Pleistocene clays are usually bluish-grey, rosty to yellow-brown, Holocene ones being black and greyish-black meadow clays. Occurring for the most part in the foreland of the Fan flank, they are also frequent in the Fan's higher-seated, waterlogged, Pleistocene depressions, showing sometimes an advanced alcalization.

Silts are also abundant near-surface sediments in the depressions of the Fan. On Pleistocene surfaces it is commonly sandy silts, on Holocene alluvium a more consolidated and fixed type of silt that are predominant. The first stage (Upper Pleistocene) corresponds to the alluvium-fanning phase of river action, a phase during which the rivers flowed over the surface in various directions and accumulated their fine-grained waste without incising a channel bed into the ground. During the second phase (Holocene) the secondary redeposition of the alluvium took place. In the Pleistocene the eolian accumulation simultaneous with the accumulative action of the rivers resulted in the development of a mixed, socalled infusion loess, sequence consisting of fluviatile and airborne dust sediments (B. BULLA 1937—38, I. MIHÁLTZ 1967, M. ANDÓ 1964 etc.).

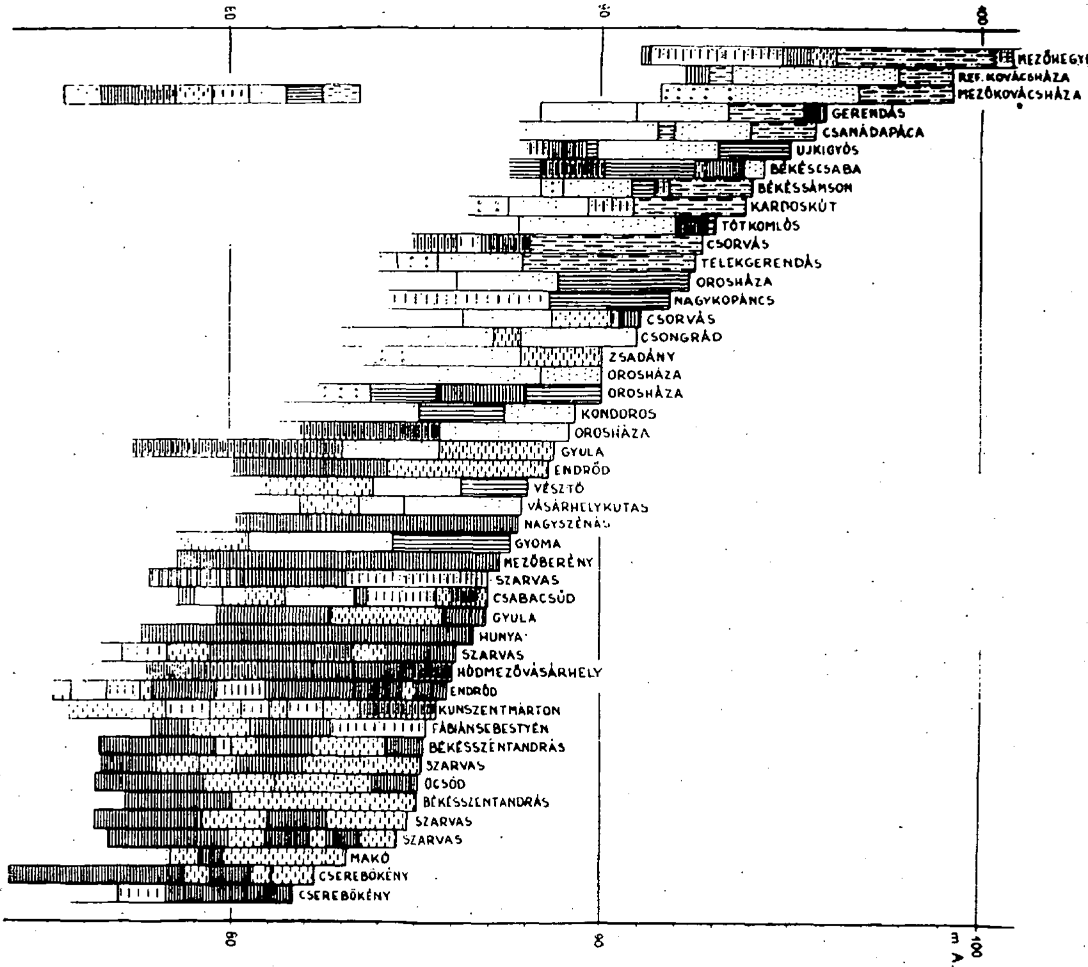


Fig. 4. Near-surface stratification characteristic of the hypsometric height of the surface of the Körös—Maros Interfluve Plain
1 = sandy loess, 2 = infusion loess, 3 = sand, 4 = silty sand, 5 = sandy silt, 6 = silty clay, 7 = clay, 8 = gravelly clay.

Typical loess is represented by traces. The infusion loess layer averages 1.5 to 2 m in thickness, though in the western part of the Fan (vicinity of Hódmezővásárhely) it is known to occur in a thickness of 7 m (Fig. 6). The accumulation of loess sediments in the first stage coincided with the accumulative action of the rivers. This is the reason why in the Great Plain loesses the ratio of river-transported sediment is at least as high (sand, silt) as that of airborne dust. It can be ascribed to those genetic circumstances that the loess sediments in the Körös—Maros Interfluve are not typical, but represent a largely mixed and altered loess-

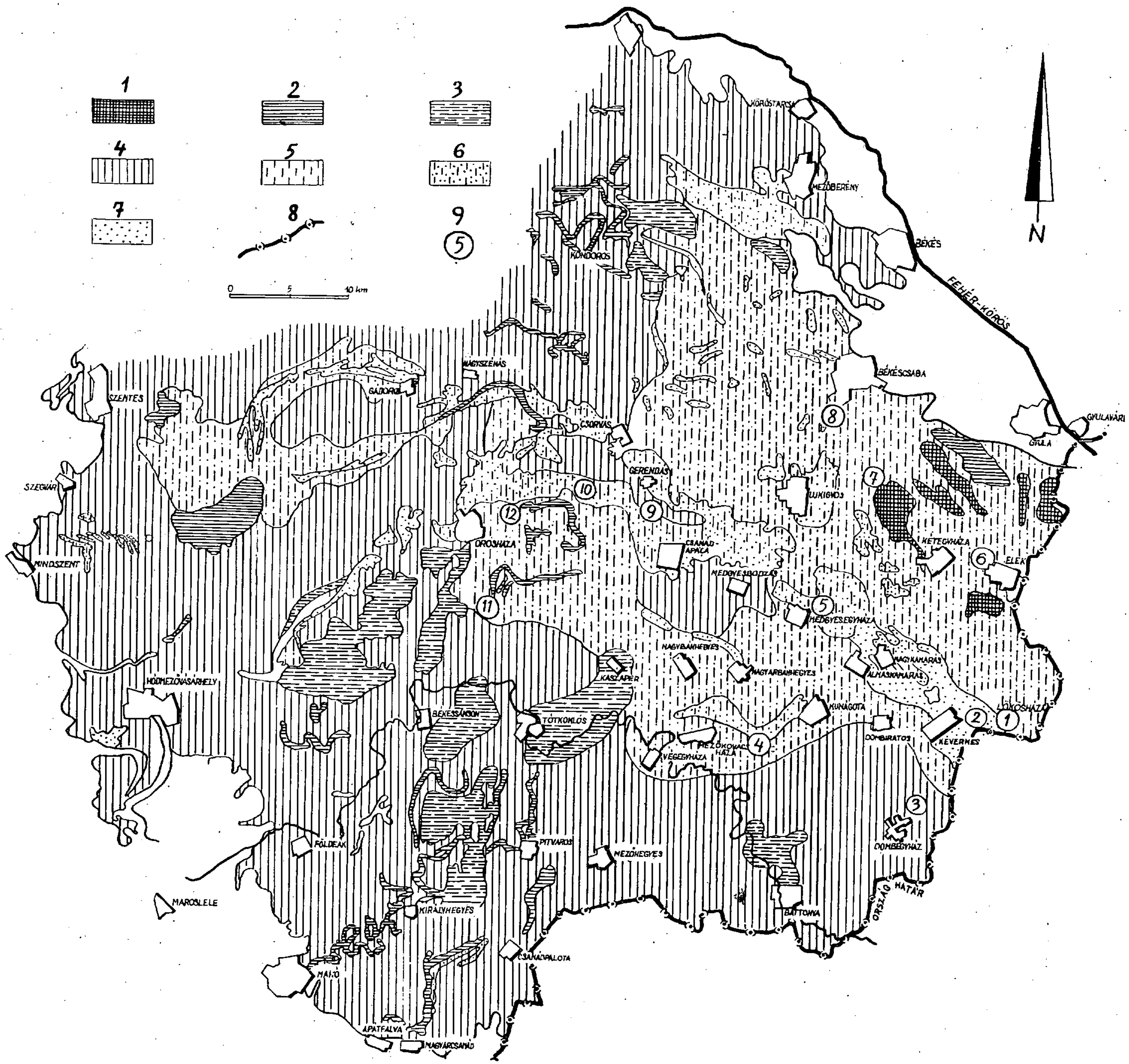
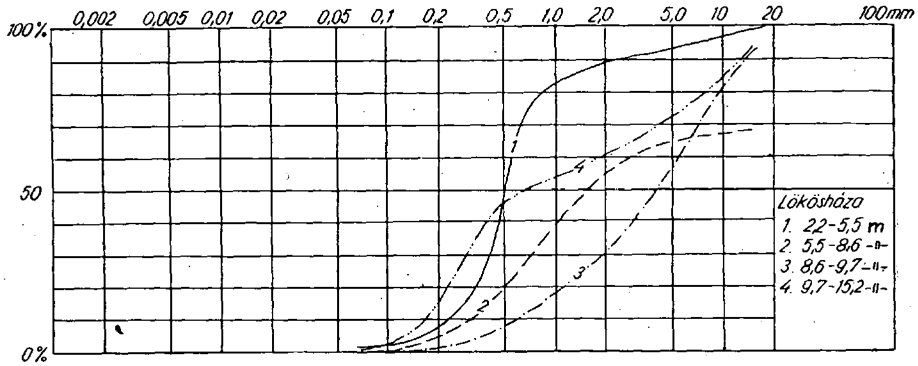


Fig. 5. Near-surface sediments
1 = alcalized silt, 2 = meadow clay, 3 = clayey, alcalized silt, 4 = infusion loess, 5 = sandy loess, 6 = loessic sand, 7 = fluvio-eolian sand, 8 = frontier, 9 = borehole points and granulometric curves.

1.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Lököshàza
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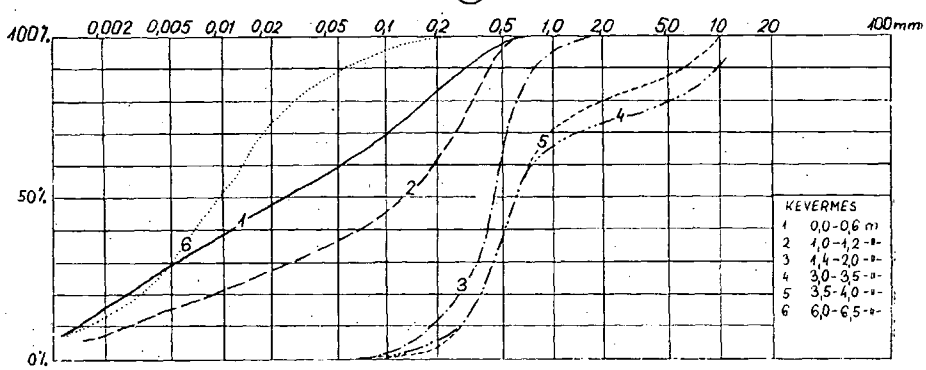
2. 5,5-8,6 -"-
3. 8,6-9,7-"-
4. 9,7-15,2-"-

2.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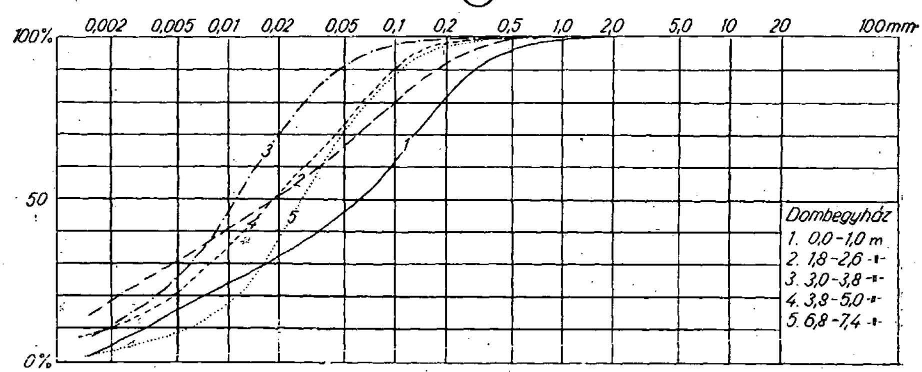
KEVERMES
1 0,0-0,6 m
2 1,0-1,2 -"-
3 1,4-2,0 -"-
4 3,0-3,5 -"-
5 3,5-4,0 -"-
6 6,0-6,5 -"-

3.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Dombegyház
1. 0,0-1,0 m
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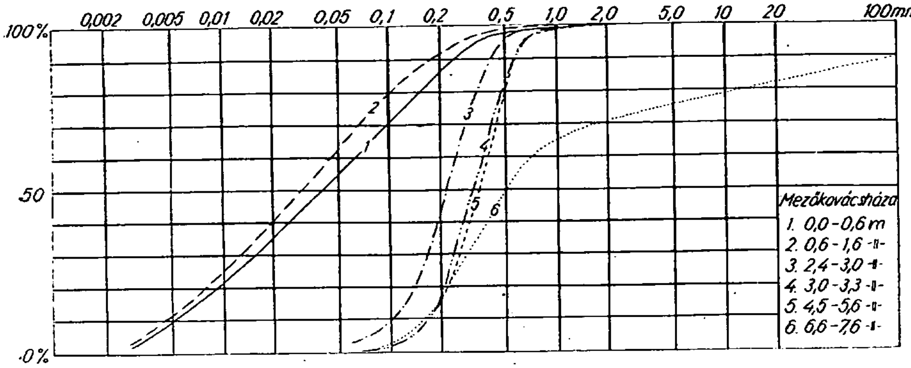
3. 3,0-3,8 -"-
4. 3,8-5,0 -"-
5. 6,8-7,4 -"-

4.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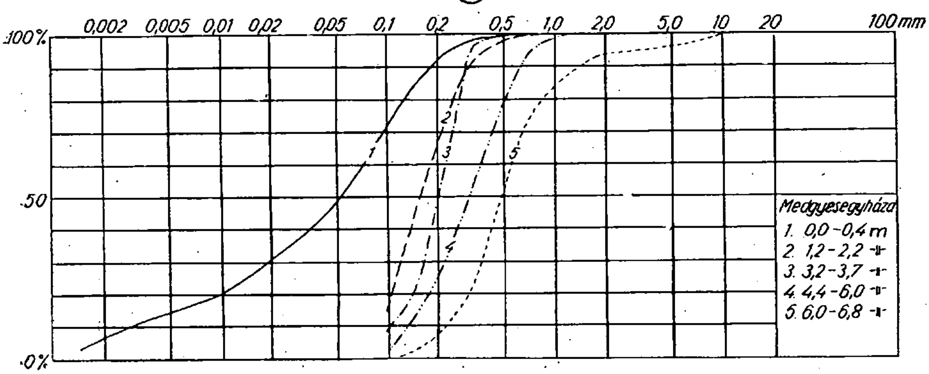
Mezőkovácsháza
1. 0,0-0,6 m
2. 0,6-1,6 -"-
3. 2,4-3,0 -"-
4. 3,0-3,3 -"-
5. 4,5-5,6 -"-
6. 6,6-7,6 -"-

5.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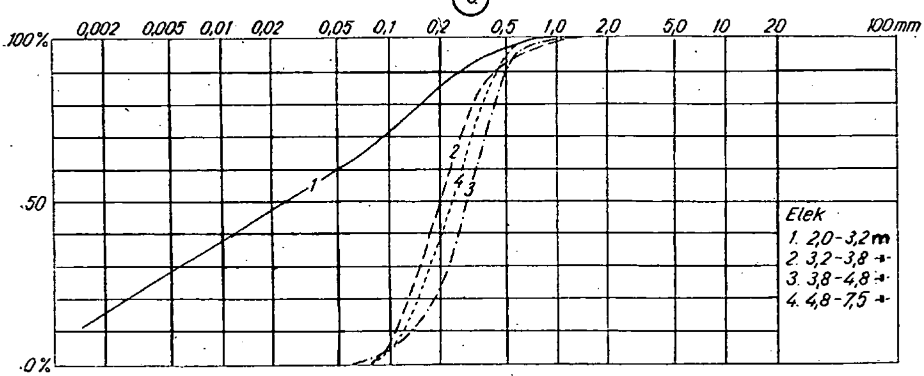
Medgyesegyháza
1. 0,0-0,4 m
2. 1,2-2,2 -"-
3. 3,2-3,7 -"-
4. 4,4-6,0 -"-
5. 6,0-6,8 -"-

6.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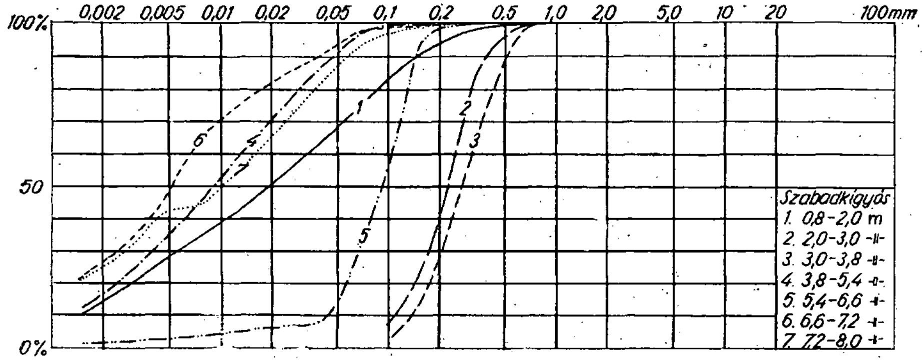
3. 3,8-4,8 -"-
4. 4,8-7,5 -"-

7.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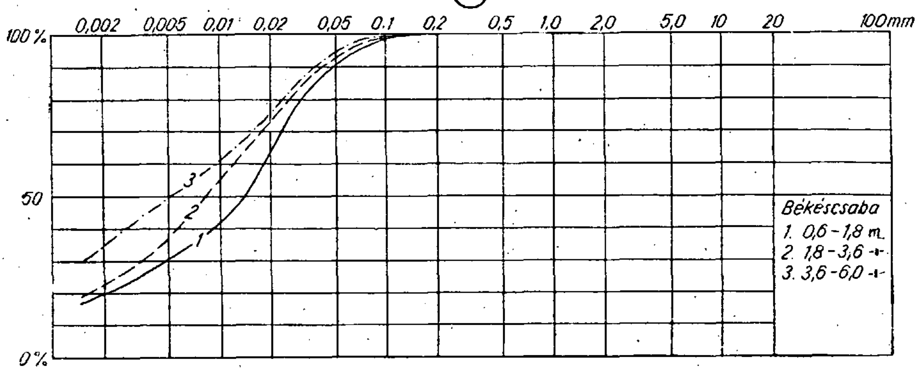
Szabadkígyós
1. 0,8-2,0 m
2. 2,0-3,0 -"-
3. 3,0-3,8 -"-
4. 3,8-5,4 -"-
5. 5,4-6,6 -"-
6. 6,6-7,2 -"-
7. 7,2-8,0 -"-

8.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Békéscsaba
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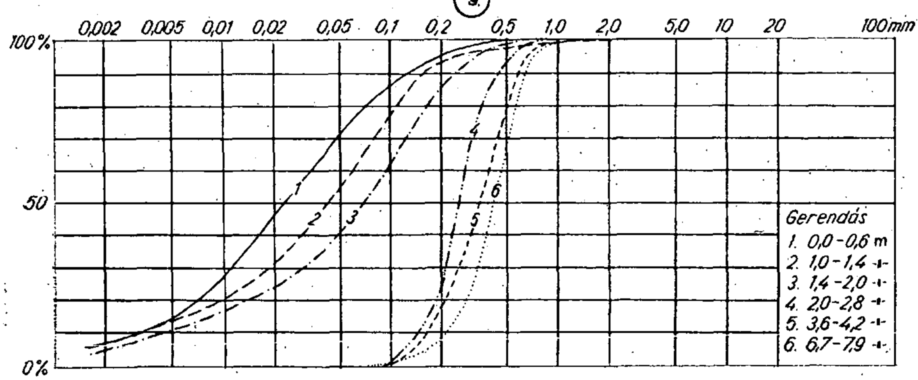
2. 1,8-3,6 -"-
3. 3,6-6,0 -"-

9.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Gerendás
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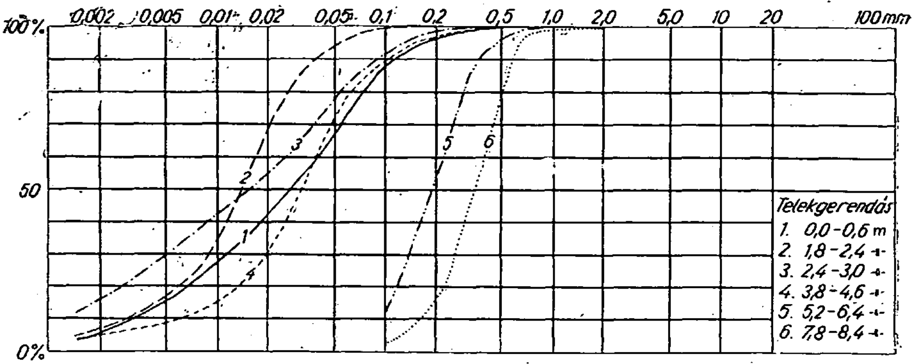
2. 1,0-1,4 -"-
3. 1,4-2,0 -"-
4. 2,0-2,8 -"-
5. 3,6-4,2 -"-
6. 6,7-7,9 -"-

(10)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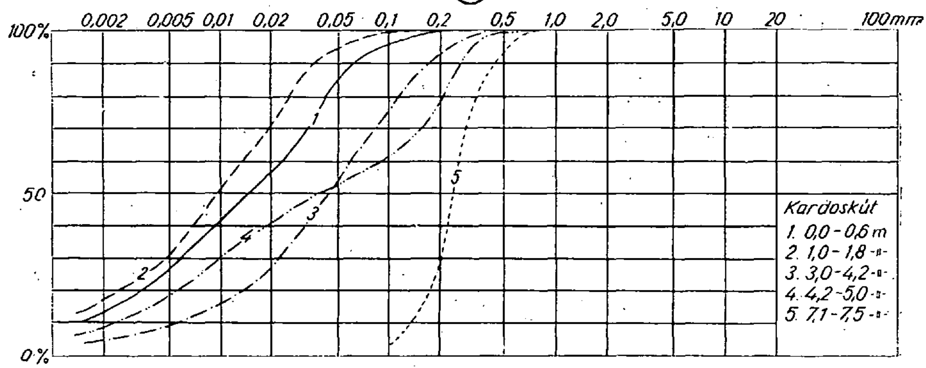
Telekgerendás
1. 0,0-0,6 m
2. 1,8-2,4 -"-
3. 2,4-3,0 -"-
4. 3,8-4,6 -"-
5. 5,2-6,4 -"-
6. 7,8-8,4 -"-

(11)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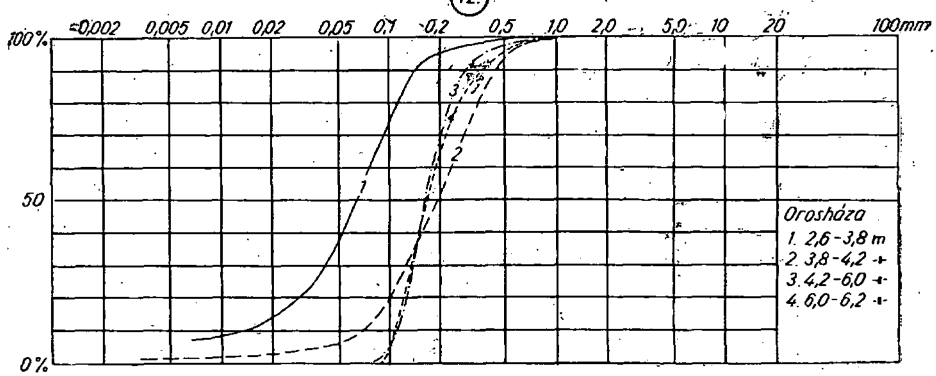
Kardoskút
1. 0,0-0,6 m
2. 1,0-1,8 -"-
3. 3,0-4,2 -"-
4. 4,2-5,0 -"-
5. 7,1-7,5 -"-

(12)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100mm
Orosháza
1. 2,6-3,8 m
2. 3,8-4,2 -"-
3. 4,2-6,0 -"-
4. 6,0-6,2 -"-

infusion loess. The variety loess types responsible for the marked heterogeny of surface sediments were developed as early as during depisition. The eolian formation was particularly altered in the Holocene subsidences. Here accumulation and alteration have led to the formation of so-called loamy layers between lacustrine and fluviatile sediments, layers which are though close to the loess fraction, but which show a structure other than that of loess. For this reason, they cannot be called loess, of course.

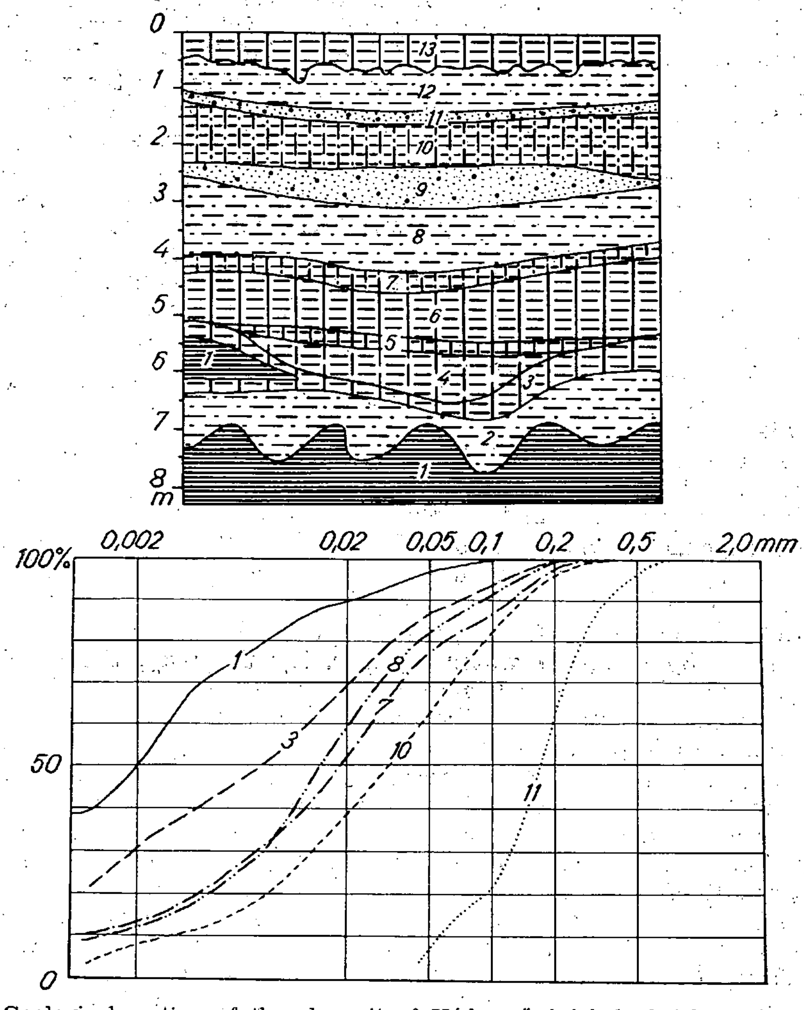

Fig. 6. Geological section of the clay pit of Hódmezővásárhely brick-yard and granulometric curves of the particular layers
1 = silty clay, 2 = largely loessic silt, 3 = clayey-loessic silt, 7 = loessic silt with fine sand, 8 = loessic, silty sand, 9 = small sand with fine sand, 10 = silty loess with fine sand, 8 = loessic, silty sand, 9 = small sand with fine sand, 10 = silty loess with fine sand, 11 = small to medium sand, 12 = loessic silt, 13 = humic, loessic silt.

In higher morphological position the mechanism of loess formation seems to have been different. Here the airborne dust, once settled down the surface, has remained in situ. However, a purely eolian accumulation cannot be spoken of here either, since the accumulative action of the river was also at work. Generally speaking, the loessic sediments of higher morphological position have been mixed with sands, while those of lower morphological position rather with silts and clays.

On the regional scale, the upward decrease in grain size is noteworthy in connection with the stratification of infusion loess sediments. This phenomenon can by no means be explained by a gradual decrease of eolian action, the progressive weakening of river water mechanism being rather apt to account for it. The structure and composition of infusion loesses can also be relied upon for conclusions as to the efficiency of morphogenetic agents. In case of airborne dust mixed with coarser sediment a comparatively more efficient accumulative action of river water, in case of silty and clayey admixtures, an accumulation by stagnant waters, can be supposed. Accordingly, two periods of eolian accumulation in the Pleistocene have been recorded. In the Körös—Maros Interfluve the afore-mentioned two loess layers are structurally well discriminable, being available in varying thickness from Hódmezővásárhely up to Békéscsaba throughout the territory.

Let us summarize now the most general characteristics of loess sediments:

a) in the Körös—Maros Interfluve influsion loesses show a heterogeneous areal distribution, being represented by numerous types in terms of grain size and structural features.

b) On surfaces, where infusion loesses are mixed for the most part with clays, surface erosion is more advanced than in areas of sand-and-loess mixtures.

c) On account of differences in quality, the various surfaces are characterized by different water regimes. By the way, the qualitative divergencies of the various chernozem soil types are accounted for, among other causes, by differences in the composition of the bedrock, this being one of the most important causes.

As shown in the above, the morphological forms of the territory have been shaped and modelled by river water and wind actions since the end of the Pleistocene up to the present time. Manifestations of periglacial frost action are rather sporadically observable in the uppermost 6 to 8 m of clayey silt of the Pleistocene sequence. River incisions have brought about a palaeostream system of NE-SW and NW-SE strike, with axes running mostly in NE-SW direction on the Pleistocene ridge facing the Tisza Valley (along the valley lines of the paleostreams) and in NW-SE direction in the zone facing the Körös rivers. This paleohydrographic pattern is closely connected with the uneven subsidence of the flank of the Maros Alluvial Fan, a process which seems to have been considerable in Late Pleistocene and Early Holocene times. In general, the peaks of the Pleistocene ridge of the Körös—Maros Interfluve indicate the extension of the Fan: the sands on the flanks of the Fan have been arranged

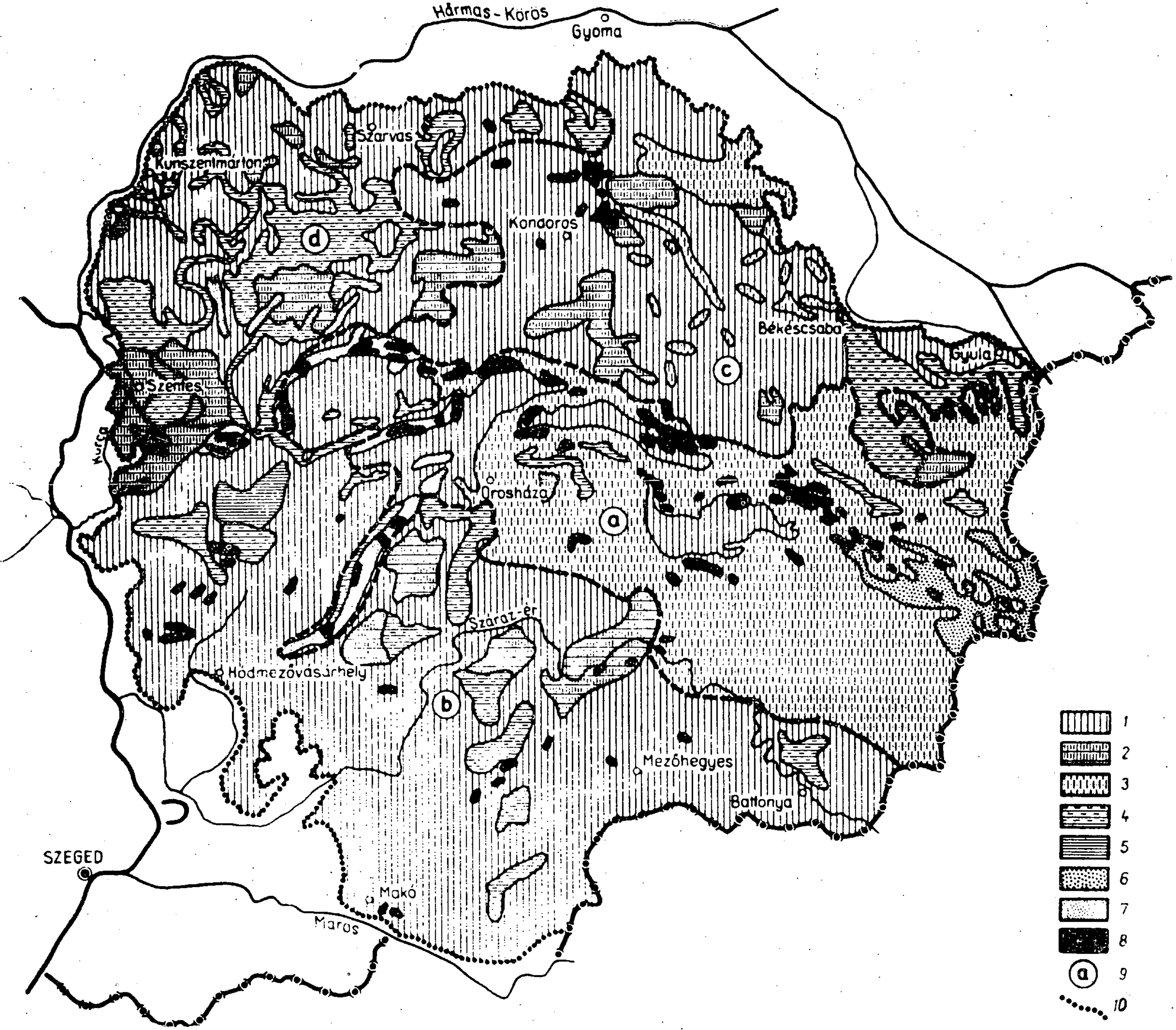

Fig. 7. Morphological sketch of the Körös—Maros Interfluve Plain (plotted by M. Andó)
1 = Large Pleistocene level surfaces covered by a thick layer of infusion loess, 2 = Surfaces which used to be waterlogged in Early Holocene time and which are presently covered by clayey loess, 3 = recent alcalized surface deposits of filled-up stagnant water ponds and rivers, constituted by clayey, sandy and loessic silts, 5 = meadow clay surfaces under high rate humification, 6 = river-deposited sand, 7 = near-surface wind-blown sand, 8 = lofty sand dunes as landform assemblages marking the extension of the alluvial fan, 9 = geomorphological micro-regions, 10 = boundary of geomorphological region.

by deflation into dune ranges. Two continuous sand belts can be observed. The outer belt runs from the vicinity of Nagyszénás to the west, towards Szentes and Mindszent. The inner belt can be traced from the south-eastern frontier zone via Orosháza up to Hódmezővásárhely. The dune range is no always parallel to abandoned river channels. In other words, both river bank dunes and scattered minor dunes are available in the territory. Such are the sandy-loess-cavered sand forms occurring along the Kondoros—Mezőberény—Békéscsaba line and in the vicinity of Gyula—Kétegyháza. Not in all of the cases is the sand range the result of deflation and eolian accumulation. Nota bene, the sand layer sometimes comprises coarsegrained, well stratified fluviatile sands, too. Hence, these sand forms can be considered to be fluvio-eolian formations as well as erosion residues between one-time river channels.

During the Holocene the abandoned channels were filled up almost completely, so that now they are traceable just in some places, where they form shallow hollows. In the depressions, meadow clays, clay-silts, redeposited loesses are directly underlain by fluviatile deposits (sands) showing a gradual decrease in grain size northwestwards, along the river valley (ANDÓ—MUCSI 1969).

The Late Pleistocene to Early Holocene history of the Hungarian part of the Maros Alluvial Fan has been summarized in Table 4. In this the rhythm of accumulation in areas of morphologically „high" and „deep" position can be recognized. It seems probable that the Maros, which at the beginning of the Holocene lay 40 km away, flowed in a fan-like pattern in various directions over its alluvial fan (which was completely built up by the end of the Pleistocene), after leaving the valley floor of the Apuseni Mountains and that not until the end of the Holocene did it occupy its present-day channel. The Holocene rhythm can be split up into two phases: an Early Holocene, living river-water phase and a Late Holocene ox-bow and lacustrine phase with intermitting dry and waterlogged conditions of environment. Consequently, the variety of present-day geomorphological forms was brought about for the most part in Late Holocene time.

4. The Körös-Maros Interfluve Plain can be divided into geomorphological microregions (Fig. 7).

a) The central part of the Fan lies in the interspace of Orosháza—Dombegyháza—Elek—Csorvás. This is the highest portion of the Fan. The nearsurface sediment is represented for the most part by sands which are blanketed by sandy loesses. In this area sand dunes, river bank dune ranges and paleochannels (with axes of NW—SE trend) constitute very rich and regular form assemblages. The sand dune ranges run along the southeastern bank of the old Maros channel (Fig. 8).

In some places the sands crop out, being, however, covered by sandy loess over much of the territory. In the interspaces of dunes, in deeper-seated channels, clayey, silty sediments have been deposited as a result of poor drainage conditions which must have existed in Holocene time. The present-day drainage channels of the region are in the northwest

Table 4.

(Courtesy of Andó-Mucsi)

Altitude a. s. l.	Present-day morphological conditions	Surface under denudation (Pleistocene) "high" position			Surface under accumulation (Holocene) "low" position		
		material	age	facies	material	age	facies
— 105 m —		infusion loess	Würm	eolian (periodically water-logged)			
— 100 m —		"blue" clay			unsorted sandy silt	Bükk I. Bükk II.	ox-bows, periodically wet
		clayey silt	Würm	flood-deposited to marshy (with redeposited Upper Cretaceous pollen grains)	medium sand	Oak stage	fluviatile (parasitic channels)
— 95 m —					gravelly coarse sand	Hazelnut-Pine-Birch stage	fluviatile
					erosion "blue" clay, clayey silt	surface Würm	flood-deposited to marsch (with redeposited Upper Cretaceous pollen grains)
— 90 m —		slightly gravelly sand	Latest Riss/Würm interglacial	fluviatile (reduced amount of water)	slightly gravelly sand	Latest Riss/Würm interglacial	fluviatile (reduced amount of water)
— 85 m —		gravel, gravelly coarse sand	Riss/Würm interglacial	fluviatile	gravel, gravelly coarse sand	Riss/Würm interglacial	fluviatile

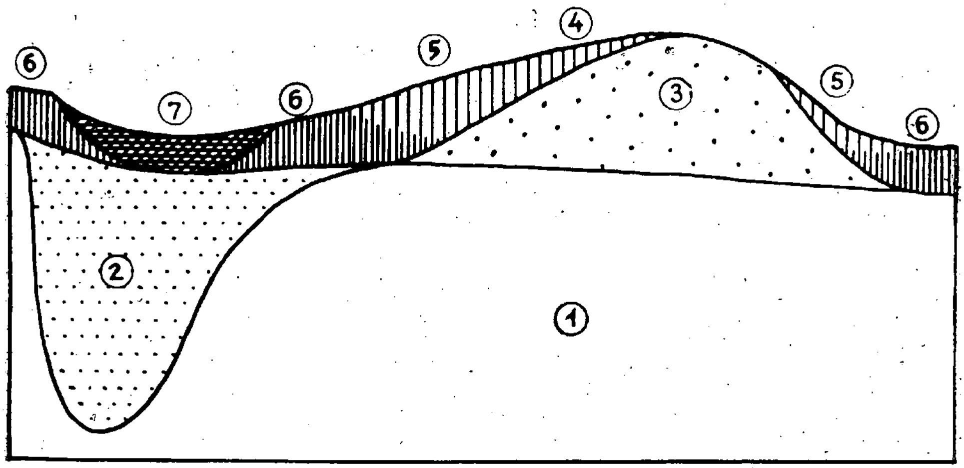

Fig. 8. Generalized profile of a river-bank dune
1 = Pre-incision deposits, 2 = palaeochannel filled up with fluviatile sand, 3 = river-bank dune sand deflated from fluviatile deposits, 4 = loessic fine sands, 5 = loess deposited on a dry surface, 7 = Holocene water stream channel, partly filled up with humic clay.

connected via Hajduér and Kórógy creek with the Tisza, in the southeast with Száraz creek.

b) The western flank of the Fan (Csongrád Plain). This is the area between Battonya—Orosháza—Mindszent and the Tisza—Maros rivers. The surface slopes slightly toward the Tisza Valley, being covered by an infusion loess blanket growing thicker westwards. In nearsurface position, the sand sequence occurs mostly just along the lines of paleochannels. Clays and silts covered by infusion loess occur frequently. This means that the surface forms a perfect plain covered by a thick infusion loess mantle. The western boundary of the west flank of the Fan is a Holocene surface brought forth by the floods of the Tisza and Maros. Morphologically, however, no sharp boundary is visible. The rather monotonous landforms of the region are offered by the level surface of the loessic platform patterned by erosion-carved depressions filled up with alcalized clays. The old river channels connected with Száraz creek now can be characterized as filled-up hollows conspicuous for different soil properties as compared to their surroundings.

c) The northeastern flank of the Fan (Békés Plain). This is an infusion-loess-covered level table-land lying between Békéscsaba—Gyoma—Csorvás, east of the source of Kórógy and Veker creeks. Its monotony is broken somehow by the meandering, deeply incised Hajdu valley as well as by the abandoned channel remnants in the vicinity of Kondoros in the southeast. A comparatively large surface depression has been developed only east of Kondoros, where the surface is covered by clay and alcalized loess. Structurally, the region is closely linked with the southern part of the Hármas-Körös foreland lying west of it.

However, the loess-like sediments, covering the surface, show a much more uniform composition here. The loess is underlain by a clay layer of considerable extension, intersected by the sand-filled belts of old river valleys, marking the tracks of Pleistocene paleochannels.

d) The southern foreland of the Hármas-Körös depression, extending up to the Nagymágocs—Kondoros—Mezőberény line, rises gradually from the Hármas-Körös valley towards the Fan. In this slightly sloping area, cutoff channels, ox-bows can be observed to lie at different heights. Properly speaking, this is the area of confluence of the old channels of the Maros and Körös-the socalled Körös Angle. The surface is mostly dissected by abandoned river channels, though 3- to 4-m-high mounds, the so-called „kunhaloms", are also frequent. (These latter represent anthropogenic features.)

Silty clays and alcalized clayey silts are common on the surface. Sands are uncharacteristic in near-surface position, but in deeper horizons thick sand layers can be found, particularly so near the rivers. In structural-morphological respect, the region can be divided into a young (Holocene) depression and an older, river-dissected Pleistocene marginal ridge of low relative relief. Whereas the former carries the Körös' valley system and latest flood-deposited sediments, the later is characterized by the old channel system of the Veker and Maros and the upfilling of these channels.

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THE GOODS AND STRUCTURE OF THE MARKETS OF SZEGED

BY I. PÉNZES

The structure of the (daily) free market supply of Szeged

Szeged, as the largest town in the southern part of the Great Hungarian Plain and as headquarters of Csongrád county exerts a very strong influence not only on its immediate surroundings (Szeged district and settlements of Csongrád county) but following from its regional functions also on settlements in Bács-Kiskun and Békés counties. (The eastern parts of Bács-Kiskun county and the western parts of Békés county have active connections with it.)

The attraction of the daily markets of Szeged is, because of their more advantageous possibilities of realization, very powerful. Consequently the radius of its supply area is large, although part of it has to be regarded only as an occasional supply area in the following called remoter autlying area. In this connection the term „occasional" means not only seasonalness of the marketed supply of goods but also changes in the goods, i. e one or the other settlement brings up once this, once that kind of commodity from this subsidiary supply zone. A stable, constant supplier in this area is only Makó with its neighborhood which is an important onion, garlic, spice root, and carrot supplier of Szeged.

The basis of our analysis is the survey we made in the markets of Szeged on saturday, 19, wednesday 23, and saturday 26 October, 1968. The period chosen can be said to have been very felicitous because it coincided with the closing of the agricultural season, harvesting. Of course this survey still could not give a complete cross-section of the supply of goods but of the lasting products serving for winter supply partly yes, because these products were marketed in larger quantities just at this time, while other, constant market goods (flowers, milk, curd, etc. were represented in average quantities.

In the course of the survey we got a true picture of the territorial distribution of the production of goods because at this time fruits and greens fit for winter storing as well as different kinds of fodder were marketed in large amounts. These latter were sold in larger amounts under the influence of the beginning of the fattening of hogs.

The survey was well-timed also because we could thus get fairly exact information about the territorial origin and amounts of the goods produced in the previous season (summer).

Since among the different kinds of circulation of goods the attraction of the center is best reflected by the free market form, of the many components of goods supply we selected only this for our study. Perhaps it is not necessary to say that in our survey we could not aim at completeness even in spite of the reflection of facts and realities, for in the survey we intentionally did not take into account the purchases by factories (on contractual basis) or the MEZÖKER. Trading Company for Agricultural Products), which, on account of their peculiar lines, depend on national centers or export and are relatively independent of local centers.

The role of the free market in the food supply of the population in our towns is still important enough. According a to the surveys of 1962 the free markets of Szeged contributed 10.8% to satisfying the demands of the population in this respect, and this ratio did not change essentially despite a yearly variation of 1—2%.

We must make it clear that the shop supply is much more important in spite of the not inconsiderable role of the free market. It seems that our undertaking was not fruitless, because we have achieved our aim which was to investigate the degree of participation of the settlements in the supply of the town of Szeged and the territorial distribution of production. Thus we got to know the origin of the free market goods, that is, the structure of production.

The ratio of the categories of goods from the various sectors on the basis of the Forint value of the goods brought (daily) to the free markets of Szeged

The marketed volume of goods on 3 market days was calculated (for each kind) with the average market prices that is, the amount of the marketed goods was reckoned over into Ft value. In the course of this work we found only one irregular item, garlic, of which it is commonly known that in the past years it has been an article in short supply and even at the time of our survey had an exorbitantly high price in comparison with the market prices of earlier years. While in earlier years it cost 8—12 Ft a kg, at the time of the survey it cost 22—35 Ft a kg. Fortunately, this particular situation existed only in regard of this one item, so it did not essentially influence the ratios.

Besides the differences in the intensity of attraction, the collected data also gave information on how the agriculture of the districts around the town accomodates itself, depending on their distance from the town, to the market in the vicinity.

The marketed goods were classed in 13 groups. They are shown in Table 1.

1. At the time of our survey among the products brought to the (daily) markets of Szeged greens were at the top with 21% (119,608 Ft) then came poultry and grapes and other fruits with a round 20% each (117,252 Ft) that is, a value of 112,139 Ft). The share of potatoes was also considerable (100,442 Ft) the explanation of which was the period of buying the winter supplies. At this time a considerable percentage of the market buyers buy their potato supply in one lot. Essentially the same is

Table 1.

1	2	3	4	5	6	7	8	9	10	11	12	13
Bread crop	Fodder	Bread substitues	Oil crops	Greens	Grapes and other fruits	Flowers	Live poultry	Eggs	Dairy products	Living animals other than poultry	Other animal and veget. products	Different sonsumer goods
Wheat rye rice	barley maize bran brits oats sorg-hum	potato	sun-flower	cabbage, cauliflower, paprika, carrots, vegetable marrow, green leaces and spice roots, onions, savoy, string be-ans (French beans kohl-rabi, to-mato, gar-lic, spinach, beetroot, lettuce, celery, radishes, green peas, melon, sorrel, parsley, dill horseradish sauerkraut, sour gherkins	apples, wal-nuts, pears, grapes guince-apples, figs, medlars lemons, chestnuts	in bun-ches, single, with roots	chicken chick goose turkey duck		curd sour cream milk cheese	pigeons rabbits	beans poppy seeds, honey, mushrooms egg drops (small shot noodles) noddles	soap feathers brooms door-mar

the explanation of the high ratio of the fodders (52,659 Ft), because the people living in houses with gardens in the outer zone of the suburbs but working in the industry also keep hogs. (They buy the fodder necessary for fattening in half-monthly lots).

There was a considerable amount of flowers (15.053 Ft) dairy products (15,029 Ft) and eggs, (14.198 Ft) although they did not even come near to the value of the former. Evaluating the amounts ot the different goods in the market we can see the following:

2. Of the goods marketed *greens are at the top.* They account for 21.1% ot the total amount marketed on each market day, 29% of this came from the outskirts of Szeged, 29% from districts outside the city area, 26% from the inner area, 9% from the outer area and 7% from the agglomeration zone. the outer area and 7% from the agglomeration zone.

a) The considerable volume of the production of fresh greens in Szeged is explained by the fact that the cooperatives, gardening enterprises, household farmers and small gardeners have organized their production for satisfying the daily market demands of the population. Today the town of Szeged is a rival of the traditionally greens-growing town of Makó and its environs in the daily marketing of goods but it (Szeged) surpasses also the other wise important inner, greens-growing area in respect of the volume of marketed goods.

The cooperatives sell their products in their own stalls as producers. Thus our cooperatives try to satisfy maximally the demands of the buyers market; a proof for this is the agrucultural reorganization of our area for such purposes. In Szeged and its vicinity for instance the cooperatives grew greens (together with spice paprika) on 1768 cadastral acres as against the year 1963 when only about 1000 cadastral acres seved this purpose. The growth in 5 years was more than 700 cadastral acres.

So the large amount of greens in the market of Szeged has a real production basis.

The amount of marketed green calculated for 1000 inhabitants of the town was worth 269 Ft, which was apparently very low. In this respect it is surpassed even by the settlements of the agglomeration zone.

If we make a comparison on the basis of values calculated for 1000, Szeged is always in a disadvantageous situation as against the other major commodity-supplying settlements. In this respect it can be compared only with Makó since the difference in the population number and density of the town and the villages is of basic order. In spite of this we must say that considerable amounts of greens are produced in Szeged. This statement of ours is well proved by the ratio of marketed goods per 100 hectare (of plowland) which is equivalent to 319,4 Ft. In this respect only a few villages of the inner area can compete with it.

b) The plants and household plots of the agglomeration zone, like Szeged, have been organized for greens growing on account of the nearness of the buyers market. And the fact, that the agglomeration zone accounts for only 7% of the commodity value of all the greens marketed as compared with the contribution of the other districts, is explained by the following:

1. The territory of the whole zone is smaller than the territory of the other districts supplying the markets of Szeged;

2. The cooperative farms of the agglomeration zone grew greens on 1026 cadastral acres (together with the spice paprika-growing areas), i. e. on a considerably smaller area than in Szeged, or in other districts supplying Szeged;

3. The ratio of those employed in agriculture decreased sharply in the agglomeration zone;

4. In the last five years the rearrangement of the layers of the population of these settlements has been going on at a rapid rate. (The troubles of the cooperatives were due to this fact, and the sharp diminishing of the greens-growing areas is also connected with it).

5. During the five years the area of the agglomeration zone planted with greens has diminished by 163 cadastral acres.

6. The increased, industrially employed population of the villages of the agglomeration buys the greens locally.

7. The independent market of Kiskundorozsma buys up largely the goods supply (of greens) brought to its market.

The situation of the settlements in the agglomeration zone is, from the point of view of the marketing of greens, much more favorable if we examine the data in terms of forint value per 1000 inhabitants. In this case even two villages surpass Szeged in the amount of goods marketed, and two villages take nearly identical forint values to the markets of Szeged on each occasion. Within this zone only Algyő constitutes an exception. In respect of the value marketed per 1000 persons Tápé stands out with a sum of 560 Ft.

According to the values calculated for 100 cadastral acres (319.4 Ft) Szeged's marketed amount of greens far surpasses that of all the settlements in the agglomeration zone. Kiskundorozsma and Tápé with 86.2 Ft and 53.6 Ft respectively remain far behind it, yet these two settlements take priority in the agglomeration zone. This fact reflects clearly the difference between Szeged and the agglomeration zone and their place in greens-growing.

c) The territory of the cooperatives of the inner area planted with greens was 2602 cadastral acres in 1968.

The sown area of these products in this district has grown by 211 cadastral acres in the last five years. The district accounts for 26% of the greens supply of the markets of Szeged, so remains behind the town of Szeged and the areas outside this district. This is partly due to the fact that the cooperatives of the inner area grow the larger part of the greens on a contractual basis and sell them at local purchasing stations, partly to the fact that besides the greens of the fall season the favorite products of the season are grapes and other fruits. The amount of greens marketed at this time remains behind the amount of fruits marketed (in the average of the districts). Quite different is the picture if the amount of goods marketed by the villages of the area is calculated for 1000 inhabitants or 100 cadastral acres. There are considerable differences with the exception of Röszke and Deszk, all of these villages supply more grapes and other fruits than greens.

Also according to the value calculated for 100 cadastral acres Röszke and Deszk are the most important suppliers of greens in this season.

d) The outer zone surpasses, on the basis of greens supply, the agglomeration zone, but on the basis of percentile contribution it remains far behind the inner zone or the remoter outlying areas. Although the greens-growing areas of the outer zone are important, truck farming is important only in certain parts of this zone. The villages of the sandy areas grow chiefly spice paprika and fruits; thus it is only the settlements of the Tisza—Maros angle that contribute larger amount to the market supply of greens.

On the basis of the value of the marketed amount of goods the most important greens suppliers of the region are Ferencszállás, Kübekháza and Klárafalva. The other villages remain well below the average of marketing. On the basis of values calculated for 100 cadastral acres the order is the same except that the greens-growing character of Klárafalva stands out more prominently. This village is one of those settlements best specialized for greens-growing.

e) *The remoter outlying areas* contribute 29% of the total amount of goods marketed. On comparison with the other districts this ratio ensures a very high rank for this area, which is due to the greens and onion supply sent to market by Makó. This is so, because at this time already large amounts of onions, garlic, greens and carrots are brought to the market for winter storing.

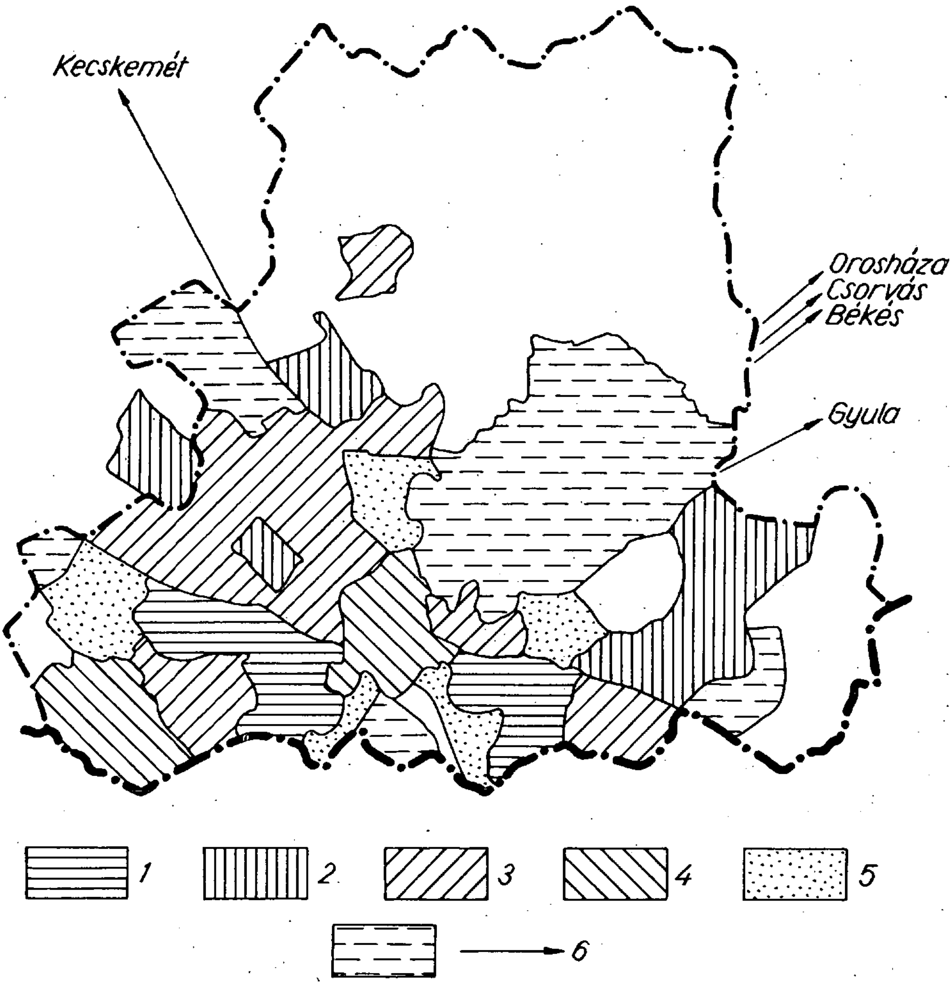
By the way even in the summer season large amounts of these goods come to the markets of Szeged from this area. Makó and its environs are constant greens suppliers to Szeged. Even from the point of view of the total value of goods marketed it is in competition with the market supply of Szeged and its inner zone.

Also on the basis of values calculated for 1000 inhabitants Makó as town surpasses the more important settlements of the remoter outlying areas with its market supply value of 884 Ft in spite ot the fact that Sövényháza, Csólyospálos, Csánytelek and Maroslele are also very important suppliers of the area.

Makó's supply of goods is prominent also on the basis of the values of marketed goods calculated for 100 cadastral acres of plowland. In this comparison the low figures of Csanytelek and Sövényháza, but chiefly of Csólyospálos are conspicuous as against Makó, Figs. 1 and 2.

3. The value of *grapes and other fruits* marketed constitutes 19.8% of the total value of the supply of one market day, that is, it does not remain much behind that of the greens.

a) However, there are fundamental differences in the territorial distribution of the market supply. While the town of Szeged and its remoter outlying areas contribute in an equal proportion to the market supply of greens, the 68% proportion of the supply of grapes and other fruits brings into relief the importance of the inner zone. The town of Szeged with its



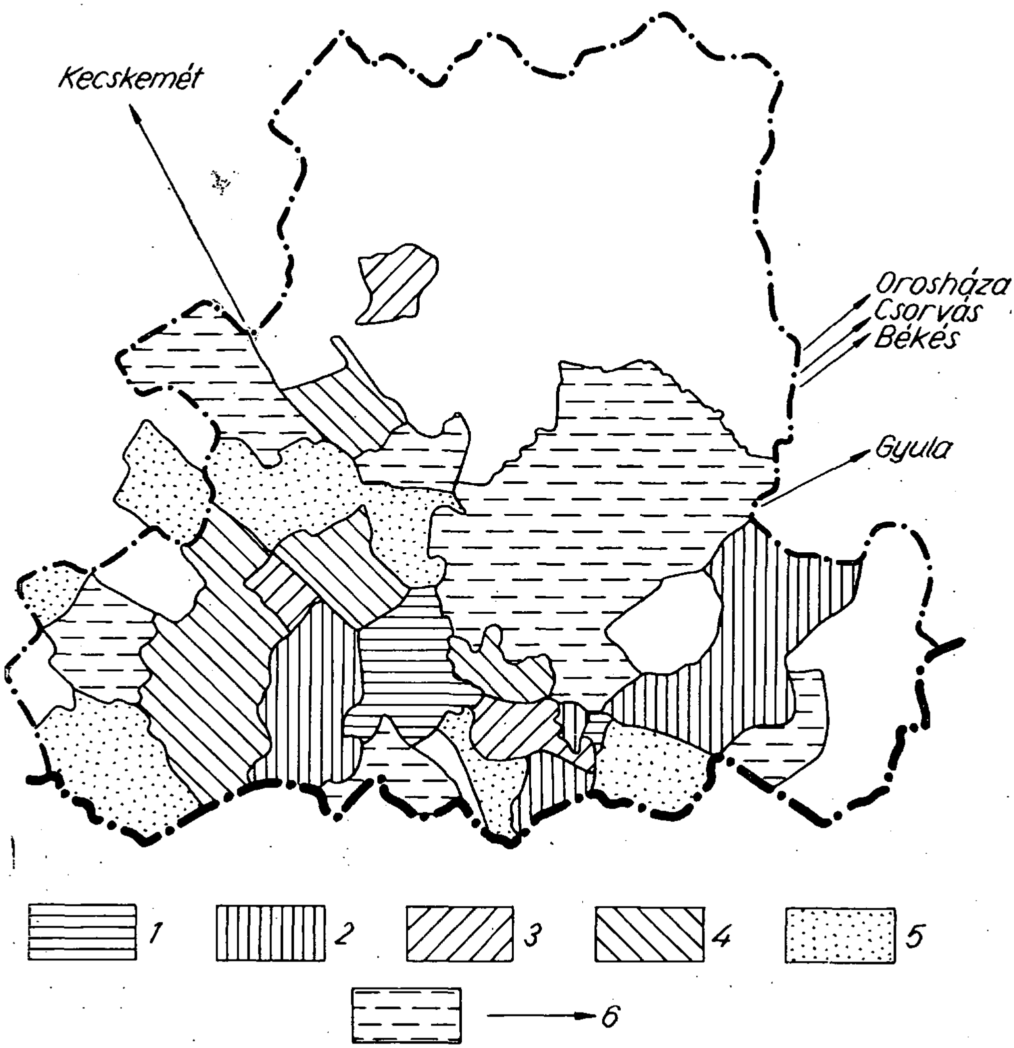
1. Ft value per 1,000 persons of greens brought to the free markets of Szeged from the different settlements.

Mean values of the different areas:

1. over 985 Ft	4. between 317—269 Ft
2. between 985—804 Ft	5. between 269—183 Ft
3. between 804—317 Ft	6. under 183 Ft

20% contribution does not even reach one third of the amount of marketed goods of the inner zone.

The large amount of grape and fruit supply at the inner zone is due partly to the fact that the distance and transport facilities of the buyers market is favorable, partly to the fact that this area is the largest grape and fruit-growing district of Csongrád county and its physical geographic-



2. Ft value per 100 cadastral acres of greens brought to the free markets of Szeged from the different settlements.

Mean values of the different areas:

1. over 319.4 Ft
2. between 319.4—76.1 Ft
3. between 76.1—54.1 Ft
4. between 54.1—35.9 Ft
5. between 35.9—12.7 Ft
6. under 12.7

al conditions are very favorable to this, and there are good old traditions of cultivation.

The 20% participation of Szeged among the district may be said to be very great, but we must know that the town is traditionally fruit–

growing. Its large garden quarters, the vegetable gardens of Ujszeged provide plenty of opportunity for gardening. Yet according to the values of marketed goods per 1000 inhabitants Szeged remains behind the inner and the outer zone. Except for two villages, only the inner zone has absolute priority which far surpasses Szeged in respect of market supply. In the outer zone, however, only the supply from Ruzsa and Ásotthalom (calculated for 1000 head) is larger than that of Szeged.

On the basis of values calculated for 100 cadastral acres of plowland the average supply of Szeged is the largest. Of the villages of the inner zona only Domaszék and Szatymaz come before it, while the marketed supply from the other settlements remains well behind it. Figs. 3 and 4.

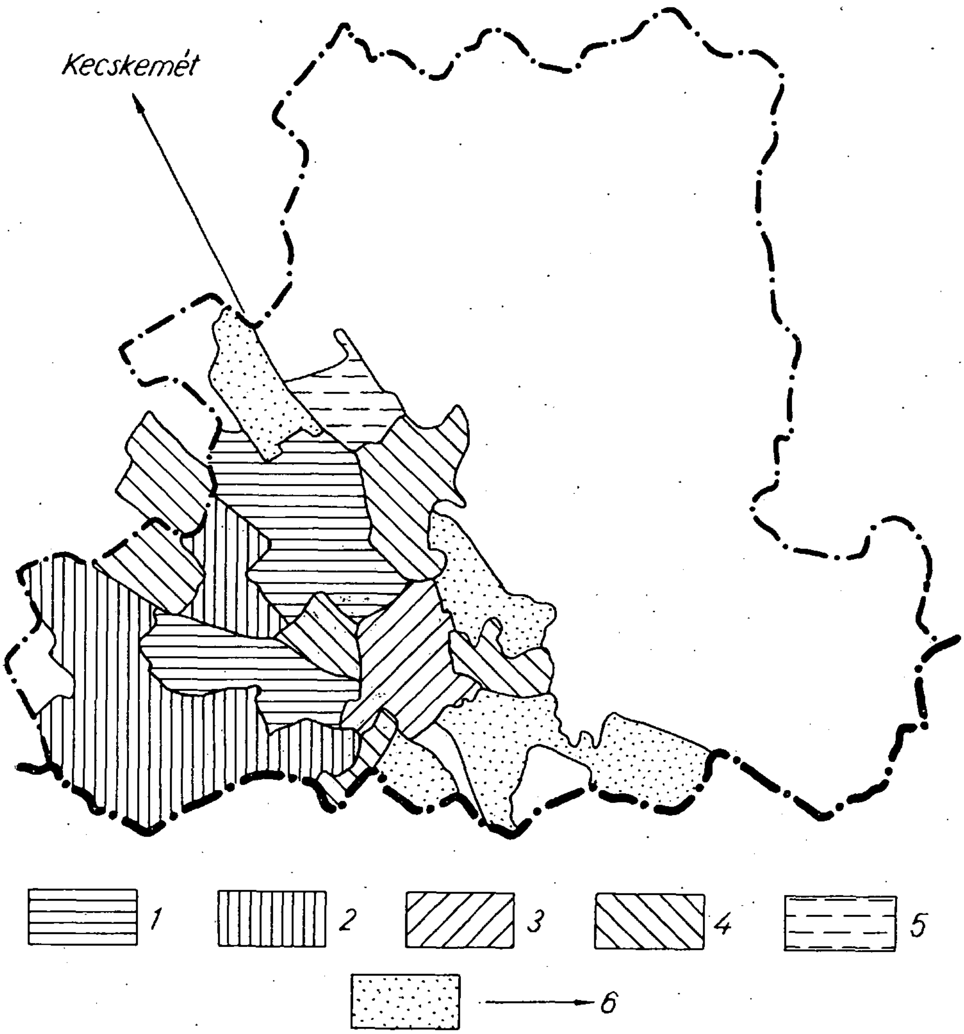
4. Among the marketed goods *living poultry* takes an understandably prominent place. Poltry consumption shows a growing tendency all over the world. In our country it was only in the sixties that fundamental changes were made in the forms and volume of wholesale raising. Csongrád county's poultry-raising is now one of the most rapidly developing industries. In Szentes a provender plant and a poultry processing factory have been established and this latter satisfies the demands and works up the surplus of Csongrád county. A part of its products are exported. A part of the town population of Csongrád county are poultry raisers themselves, but the large majority are, of course, consumers.

a) Szeged's demand for living poultry is such a force of attraction that the raisers take their stock to its market willingly even *from the remoter outlying areas.* On the days of survey the largest amounts of poultry (50%) arrived from here. In this category of commodity the contribution of Szeged is 20%, that of the inner zone 16%. This seems to suggest that the leading place of the outlying areas is not quite stable, not constant.

The large supply is explained by the fact that living poultry can be shipped to greater distances too without any major loss. Further it is explained by the fact that living poultry is a saleable commodity much in demand of which the market price margin is at least 20%, that is in comparison with most of the market goods it is the highest per kg.

b) The establishment of chicken-raising and egg-producing farms meant revolutionizing of poultry breeding which made the poultry and egg supply of the population even. It is due to this fact that egg production is no longer an exclusive speciality of homestead farms. Even in the case of the areas examined it is not the remoter outlying area that is dominant from the point of view of the marketed egg supply, but the inner zone. It is understandable that the inner zone undertook this role, the role of the supplier, for it was not remunerative for the remoter outlying areas and they did not even supply the necessary amount because there was loss on shipping owing to the great distances (high percentage of breakage.) and besides this there is less trade profit on 1 kg of eggs than on 1 kg of chicken. The agglomeration and the outlying area contribute 6% each to the chicken supply, which corresponds to the structure of the area.

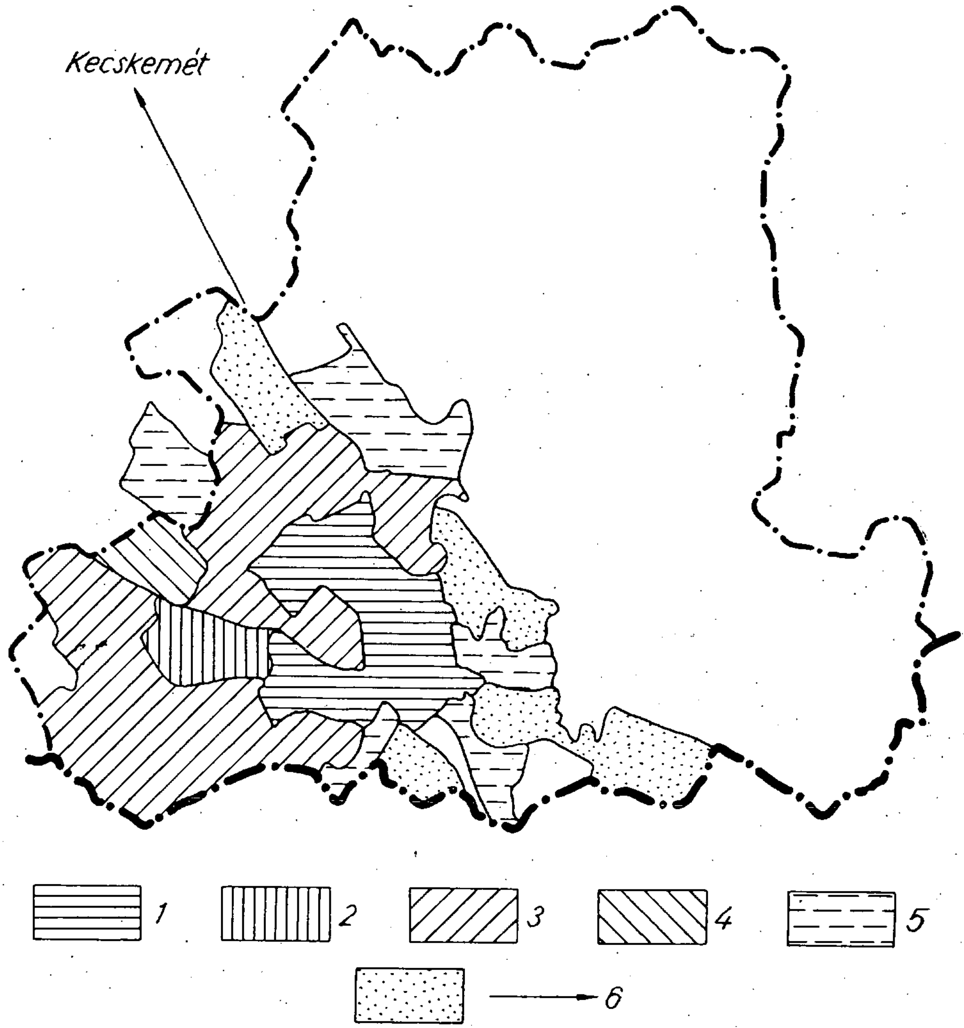
On the basis of the value calculated for 1000 inhabitants, Szeged,



3. Ft value per 1,000 persons of grapes and other fruits brought to the free markets of Szeged from the different settlements.
Mean values of the different areas:

1. over 1960	4. between 189— 88
2. between 1960—261	5. between 88— 30
3. between 261—189	6. under 30

which accounts with 196 Ft for 20% of the market supply, remains behind all the areas. Among the areas, still calculating for 1000 inhabitants, the inner zone is at the top with a value of 439 Ft, then comes the outer zone with a value of 333 Ft. In this respect the remoter outlying area comes after the agglomeration zone, that is in the fourth place.

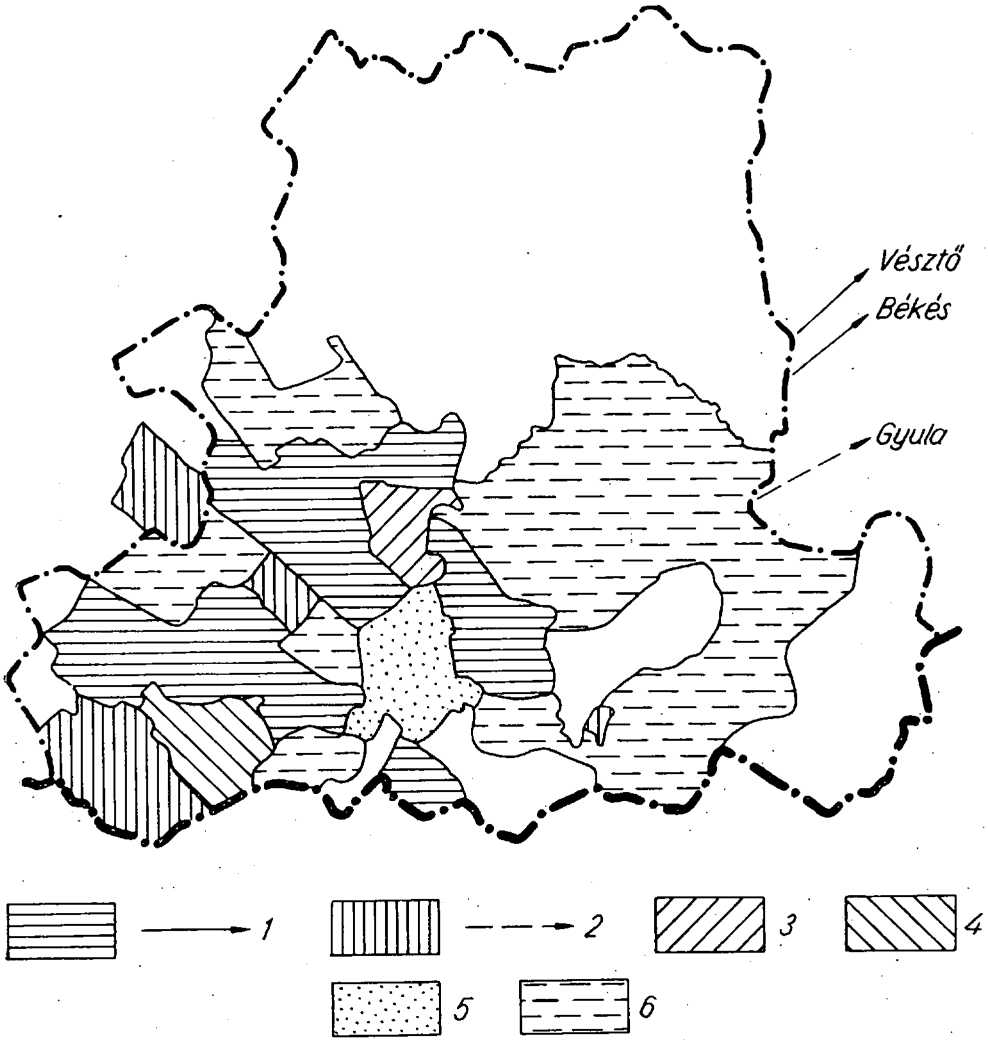


4. Ft value per 100 cadastral acres of grapes and other fruits brought to the free markets of Szeged from the different settlements.

Mean values of the different areas:

1. over 224.4
2. between 224.4—130.8 Ft
3. between 130.8— 13.9 Ft
4. between 13.9— 9.7 Ft
5. between 9.7— 2.3 Ft
6. under 2.3 Ft

On the basis of the total value of its marketed supply, as compared with that of other areas, *the remoter outlying area* had, thanks to Vésztő and Békés a leading role on the three market days examined. The amount of its supply is not constant and not characteristic on every market day;



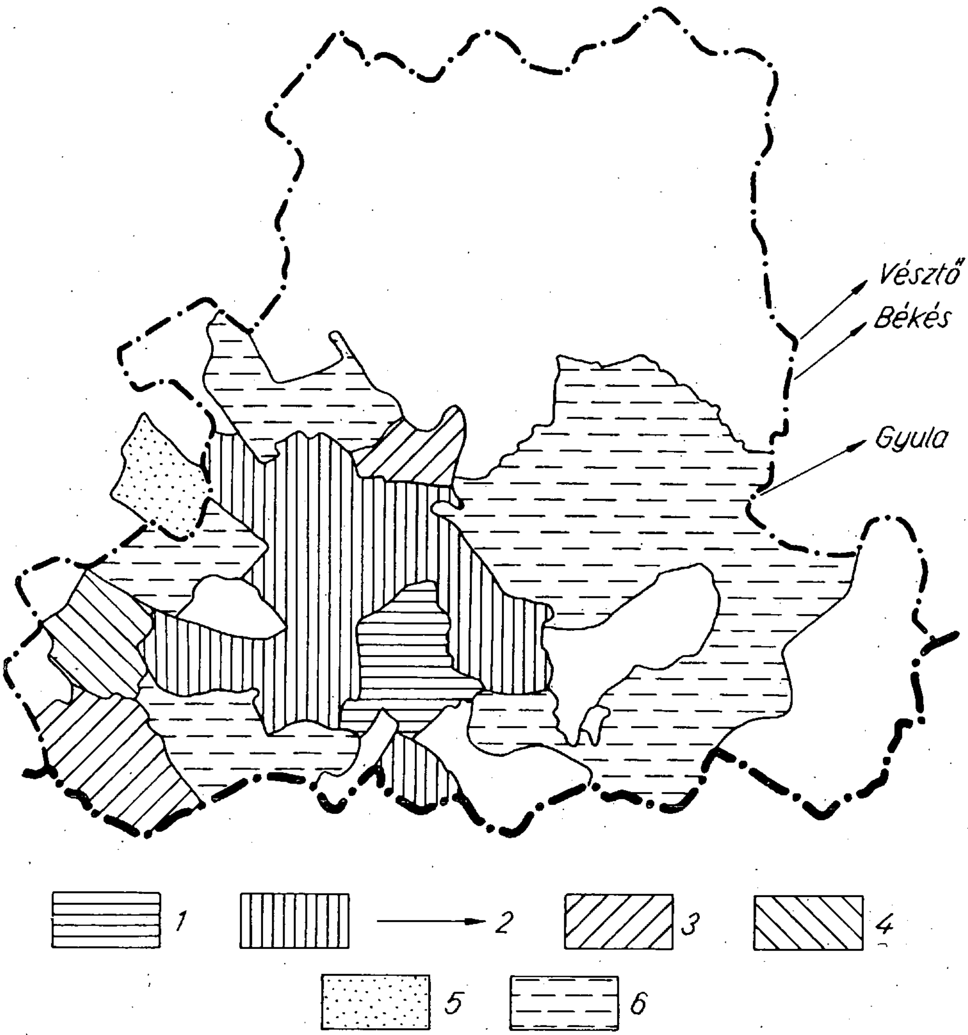
5. Ft value per 1,000 inhabitants of living poultry brought to the free markets of Szeged from the different settlements.

Mean values of the different areas:

1. over 440 Ft
2. between 440 and 334 Ft
3. between 334 and 246 Ft
4. between 246 and 223 Ft
5. between 223 and 196 Ft
6. under 196 Ft

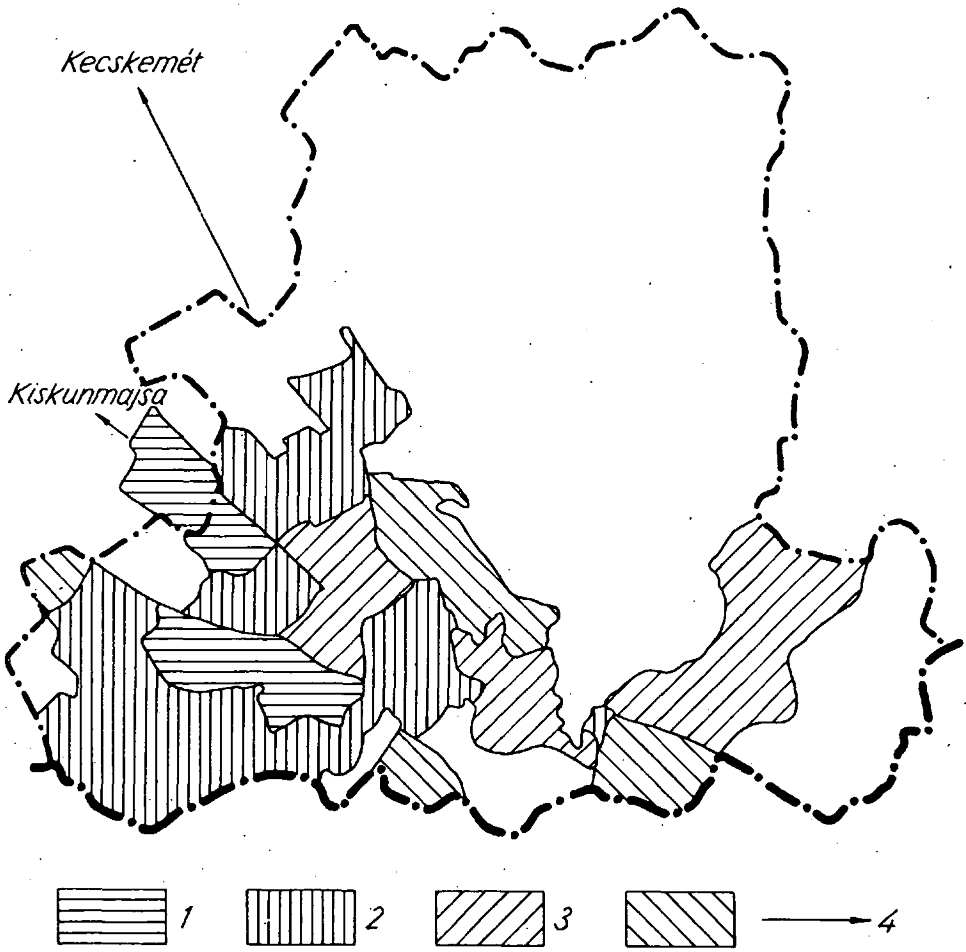
Szeged, the inner zone, and the agglomeration zone prove to be more stable suppliers.

This opinion is supported also by the values calculated for 100 cadastral acres, for no other settlement can compete with Szeged. Calculat-



6. Ft value ped 100 cadastral acres of living poultry brought to the free markets of Szeged from the different settlements.
Mean values of the different areas:
1. over 233.6 Ft
2. between 233.6 and 27.1 Ft
3. between 27.1 and 24.4 Ft
4. between 24.4 and 18.1 Ft
5. between 18.1 and 16.7 Ft
6. under 16.7 Ft

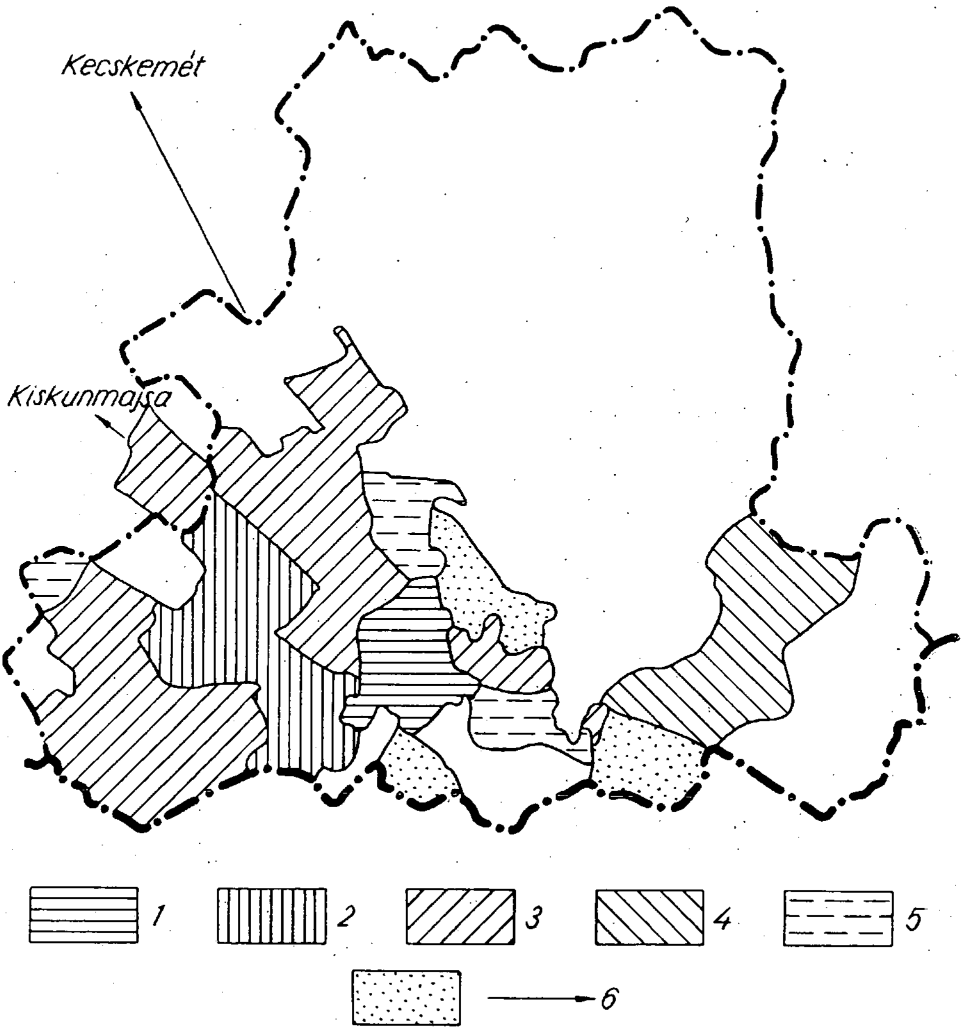
ing per 100 cadastral acres, Szeged brought living poultry to the market in the value of 233 Ft, the inner zone 27.1 Ft, the agglomeration zone 24.4 Ft. The remoter outlying area with its value of 18.1 Ft fell to the fourth place. Figs. 5 and 6.



7. Ft value per 1.000 persons of potatoes brought to the free markets of Szeged from the different settlements.
Mean values of the different areas:
1. over 1066 Ft
2. between 1066 and 310 Ft
3. between 310 and 265 Ft
4. under 265 Ft

5. On the basis of its contribution to the total value of the marketed goods *potato* stands in the fourth place with 17.8%. Since potato is a mass consumption article, it is a constant good on the markets. Large amounts of it are brought to market from the districts especially on market days in late summer and in the fall. The *inner zone* and *Szeged* contribute to the potato supply of the market 39% each.

So their leading position is indisputable. The advance of Szeged is explained by the potato dumping of the cooperatives. The 10 and 11% contribution of the outer and remoter outlying areas respectively is con-



8. Ft value per 100 cadastral acres of potatoes brought to the free markets of Szeged from the different settlement.

Mean values of the different areas:

1. over 368.7 Ft
2. between 368.7 and 67.2 Ft
3. between 67.2 and 17.2 Ft
4. between 17.2 and 15.1 Ft
5. between 15.1 and 4.9 Ft
6. under 4.9 Ft

ditioned by the great distances of haulage. This is so because transportation of large masses of goods (potato) to great distances is, on account of the minimal profit ratio between the purchase price and the market price, not profitable. The 3% achievement of the agglomeration zone is also understandable, for the potato grown here is used for the producers own consumption.

On the basis of the above facts we may say that the absolute first place of the inner zone with a value of 1066,27 Ft in the market supply of potato calculated for 1000 inhabitants is in every respect understandable because this area is the main potato producer in the sector of Szeged.

Szeged is second with a market supply value of 310 Ft per 1000 inhabitants before the 265.22 Ft market supply value of the outer zone. On the other hand it has absolute priority in the value per 100 cadastral acres which is 368.2 Ft. The inner zone remains well behind with its goods value of 67.2 Ft. Figs, 7 and 8.

6. Fodders account for 9.3% ot the total value of goods marketed. Forty per cent of this was brought from the inner zone, 26% from Szeged, and 23% from the remoter outlying area. The outer zone contributed 8%, and the agglomeration zone 3%. The high percentile contribution of Szeged is explained, as in the case of potato, by the sale of the share of the fodder crop of cooperative members.

In spite of this fact Szeged's marketed supply of fodder per 1000 capita remains well behind the inner and outer zones which anyway ensure the market supply of the greatest value. It is interesting that the roles are changed in the case of the values per 100 cadastral acres of plowland where the total amount marketed by the town is 316 Ft (100 c. a., which is incomparably higher than the mean of the other areas. Figs. 9 and 10.

7. The 2.7% contribution of Szeged to the total of marketed flowers brings the large town character of Szeged into relief. Flower consumption is directly proportional to the degree of town character or to the size of the town. (This is so because the people of the smaller settlements have an opportunity to grow flowers around their homes.) Of course, flower growing is cultivated always in the innermost parts of the zones around the town, because the fresher the flowers come to the market the more favorable may be their purchase price. In the case of Szeged we find the following facts:

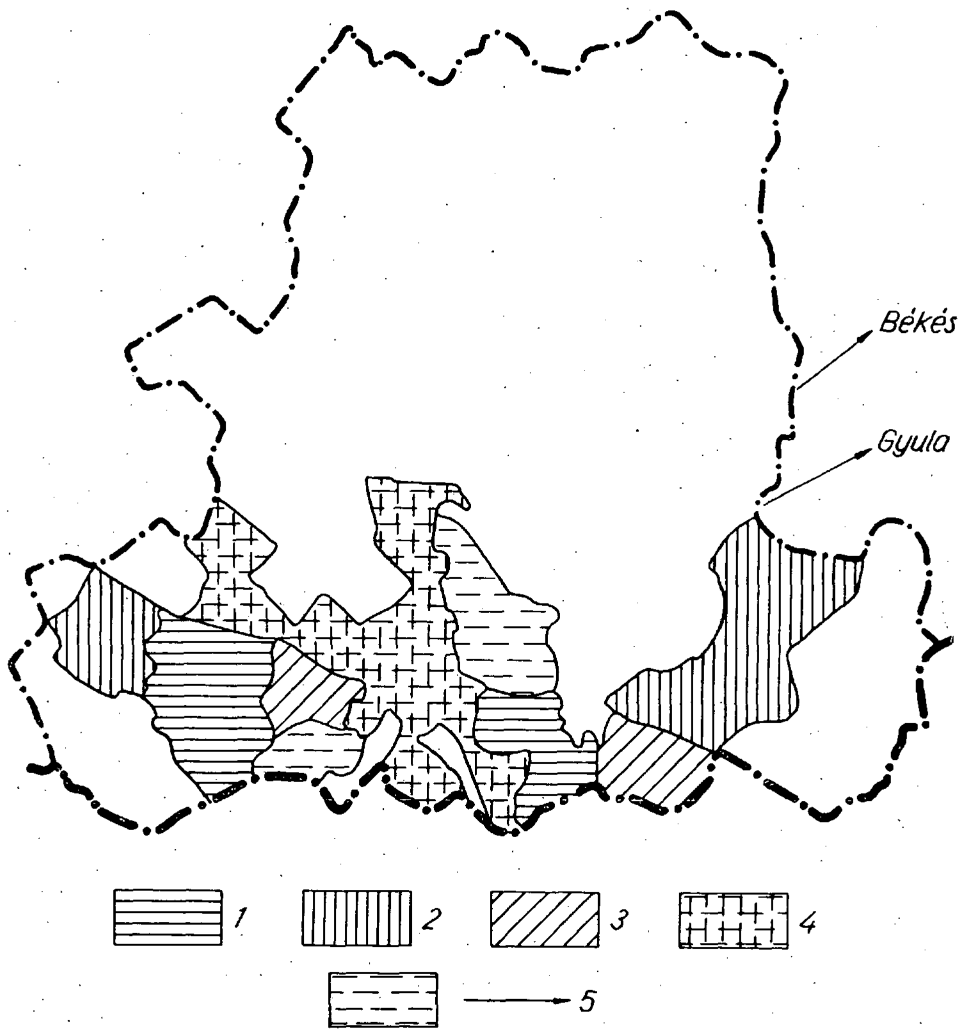
a) 80% of the value of the *flowers* brought to the market comes from Szeged, 18% from the agglomeration zone, and 1% from the inner area, while 1% comes from the outer area and the remoter outlying area.

b) In Szeged there is a greater than usual degree of specialization. This is shown by the fact that the flower supply comes nearly exclusively from the flower-gardens of the cooperatives Haladás and Felszabadulás and from the private gardens in Ujszeged, while in the agglomeration zone only the supply from Szőreg is important.

The Ft value of the marketed flower supply per 1000 inhabitants is greatest in the case of Szőreg (526 Ft), then comes Szeged with 99 Ft.

In the inner zone Röszke with 45 Ft and in the outer zone Tisza-sziget with 33 Ft deserve to be mentioned.

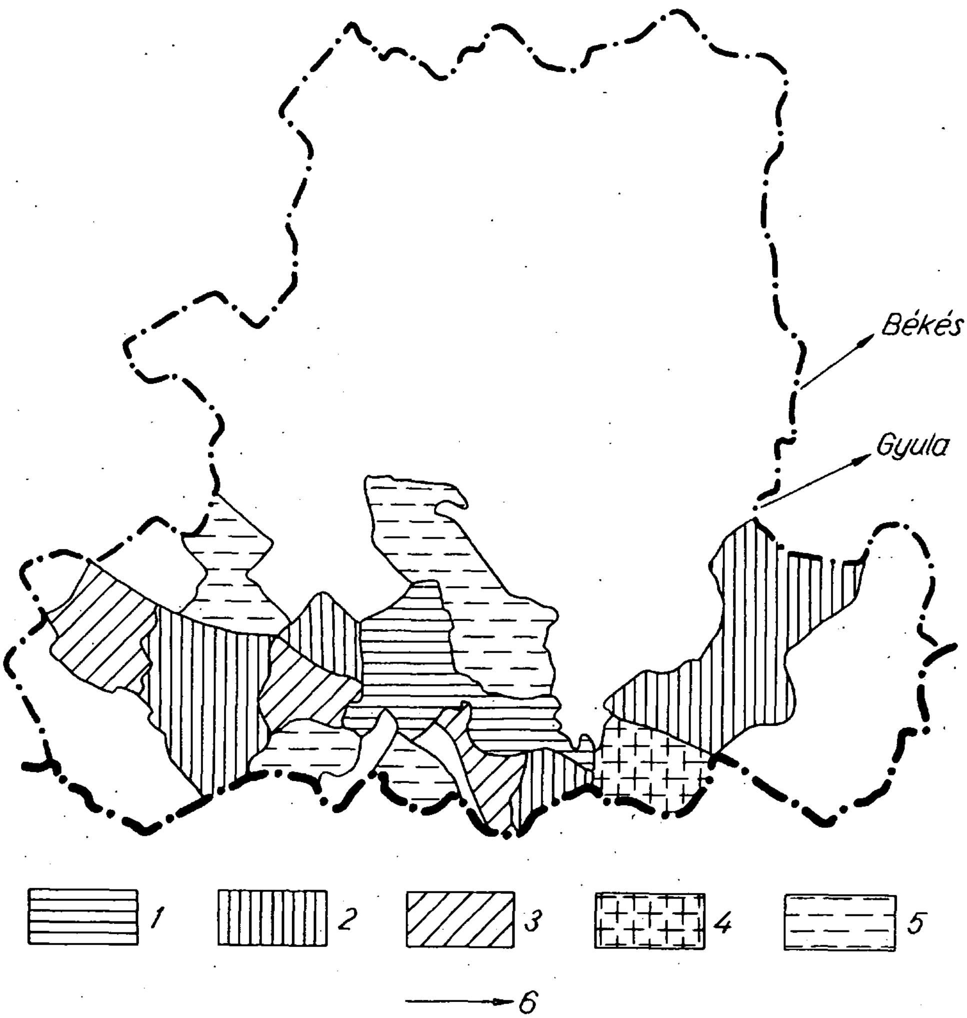
With its value of 118 Ft per 100 cadastral acres Szeged has an overwhelming superiority over all the other areas, yet Szőreg with a value



9. Ft value per 1,000 persons of fodders brought to the free markets of Szeged from the different settlements.
Mean values of the different areas:
1. over 553 Ft
2. between 553 and 241 Ft
3. between 241 and 110 Ft
4. between 110 and 43 Ft
5. under 43 Ft

of 50.5 Ft is an important rival to it. Other settlements or areas do not even deserve mention in this respect. Figs. 11 and 12.

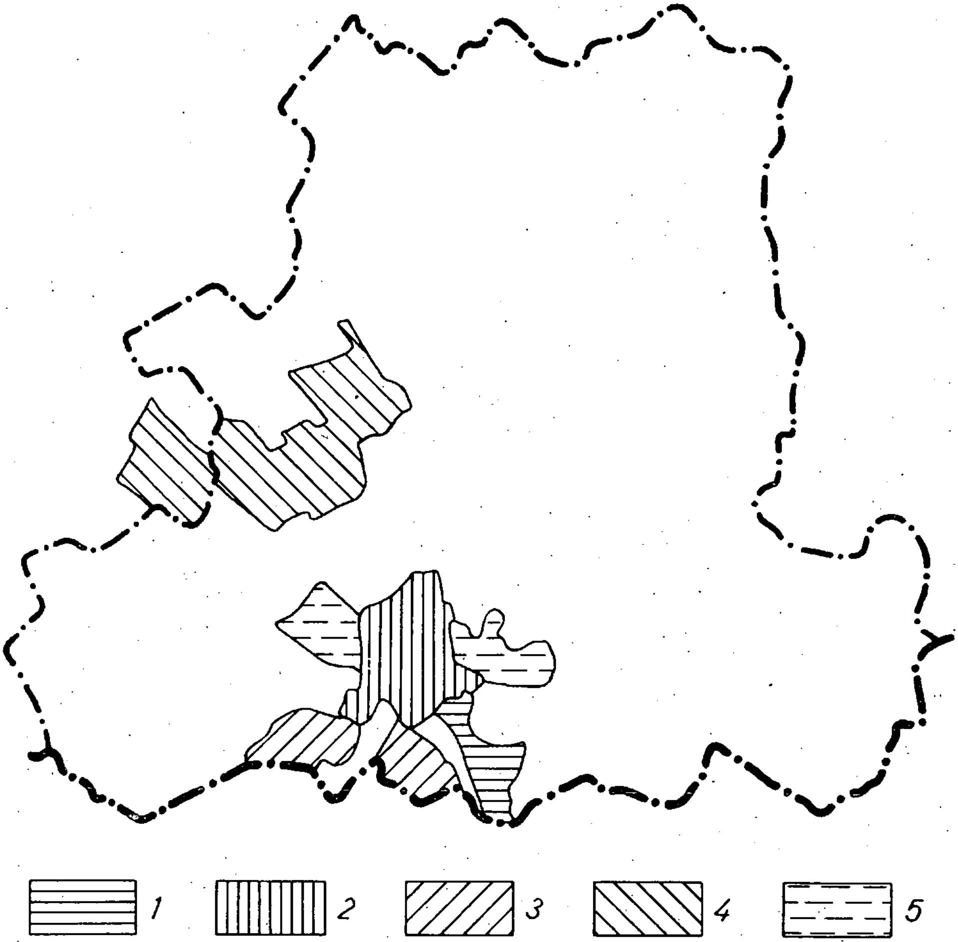
8. *Eggs and dairy products* represent approximately equal shares in the total market supply, the share of eggs being 2.5, that of the dairy products 2.7%.



10. Ft value per 100 cadastral acres of fodders brought to the free markets of Szeged from the different settlements.
Mean values of the different areas:

1. over 131.6 Ft
2. between 131.6 and 21.7 Ft
3. between 21.7 and 8.7 Ft
4. between 8.7 and 7.2 Ft
5. between 7.2 and 2.0 Ft
6. under 2.0 Ft

a) For both of these products the main supplier is the *inner zone* because 51% of the eggs, 69% of the milk and dairy products come to the markets of Szeged from this area. In respect of the egg supply the remoter outlying area is second with 21%, the outer zone and Szeged are third and fourth with 11% each, while the agglomeration zone is fifth with 6%.



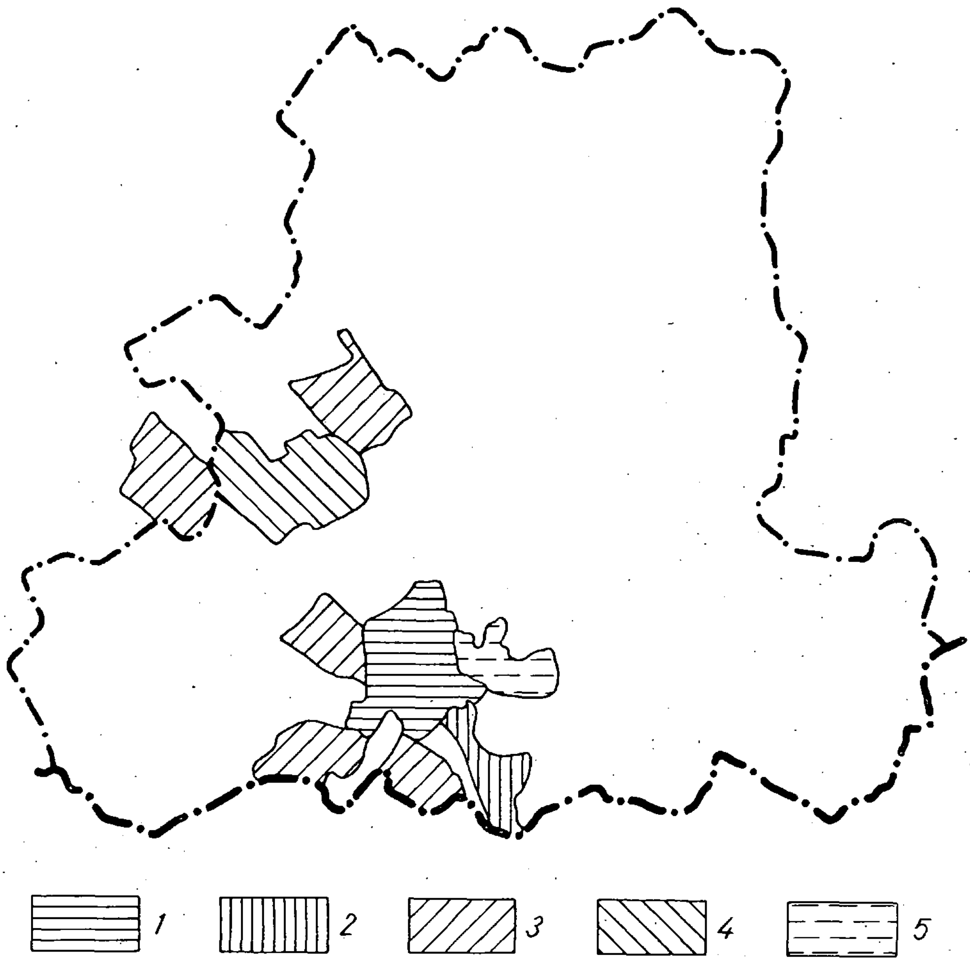
11. Ft values per 1,000 inhabitants of flowers brought to the free markets of Szeged from the different settlements.

Mean values of the different areas:

1. over 106 Ft
2. between 106 and 99 Ft
3. between 99 and 30 Ft
4. between 30 and 5 Ft
5. under 5 Ft

In respect of the supply of dairy products Szeged is second with 19%, the remoter outlying area is third, while the supply from the outer zone and the agglomeration zone is unimportant. The unimportant place of the outer zone and the agglomeration zone is milk supply is due to various causes;

The outer zone is one of the most important milk suppliers of Szeged, but it sells its surplus goods not through its free market, but through purchases by state companies. In the case of the outer zone the transport

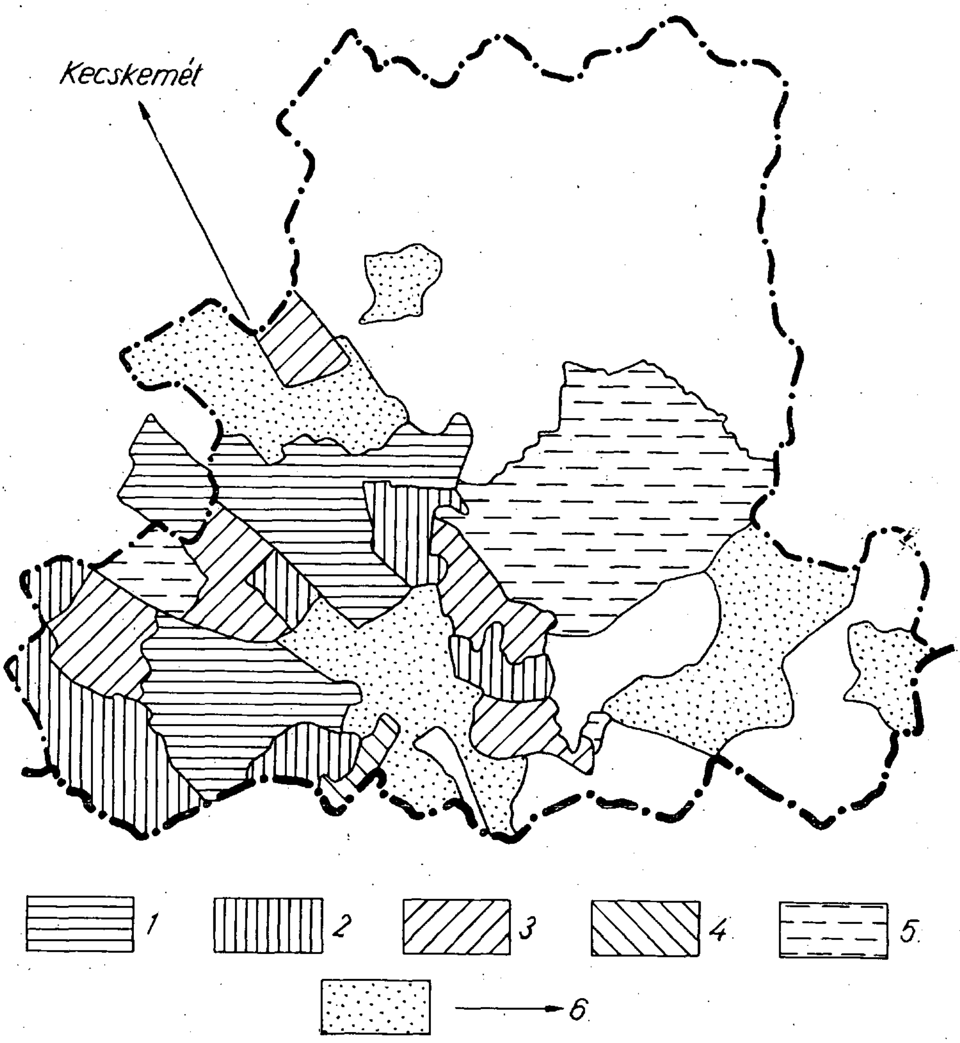


12. Ft values per 100 cadastral acres of flowers brought to the free markets of Szeged from the different settlements.
Mean values of the different areas:
1. over 118 Ft
2. between 118 and 10.2 Ft
3. between 10.2 and 0.3 Ft
4. between 0.3 and 0.1 Ft
5. under 0.1 Ft

distance also plays a role in the fact that Szeged contributes minimally to the supply of its free market.

b) Today the agglomeration zone cannot satisfy even its own demand. The balance between its consumption and production is negative and so it is an unimportant factor in the free market supply of Szeged.

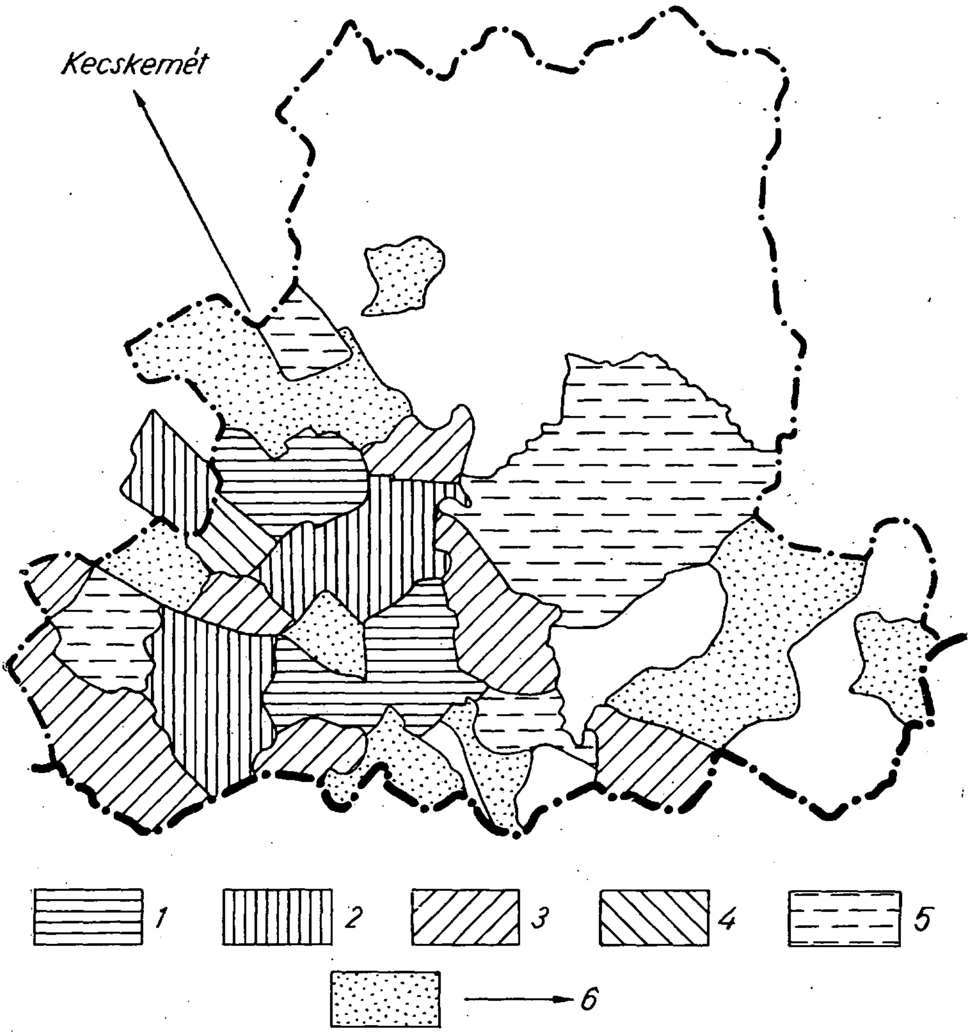
The greater contribution of Szeged to the supply of dairy goods derives from its positional advantage. The milk and dairy product supply



13. Ft values per 1.000 persons of eggs brought to the free markets of Szeged from the different settlements.
Mean values of the different areas:
1. over 155 Ft
2. between 155—67 Ft
3. between 67—33 Ft
4. between 33—29 Ft
5. between 29—12 Ft
6. under 12 Ft

of the shops of Szeged is good. So the livestock farmers of the town sell a large part of their milk and dairy products in the daily market trade.

c) The large contribution of the inner zone to the market supply of milk is partly due to the fact that more cows are kept at houses in this area, and partly to the transport distance which is not too great and so

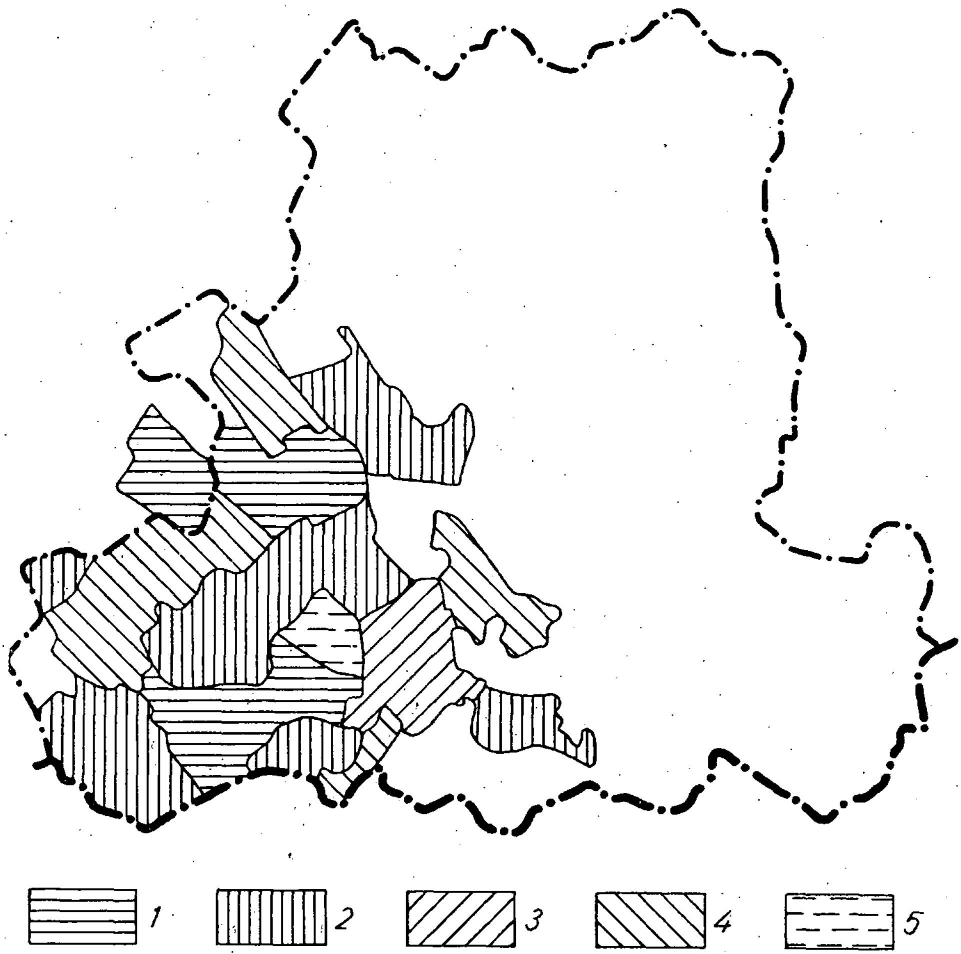


14. Ft values per 100 cadastral acres of eggs brought to the free markets of Szeged from the different settlements.
Mean values of the different areas:

1. over 14.9 Ft
2. between 14.9—9.9 Ft
3. between 9.9—2.7 Ft
4. between 2.7—2.6 Ft
5. between 2.6—1.4 Ft
6. under 1.4 Ft

it can be the free market of Szeged. Double trading is, however, characteristic of this area, too. It markets the milk and dairy products produced by it partly through purchasing, partly through selling on the free market.

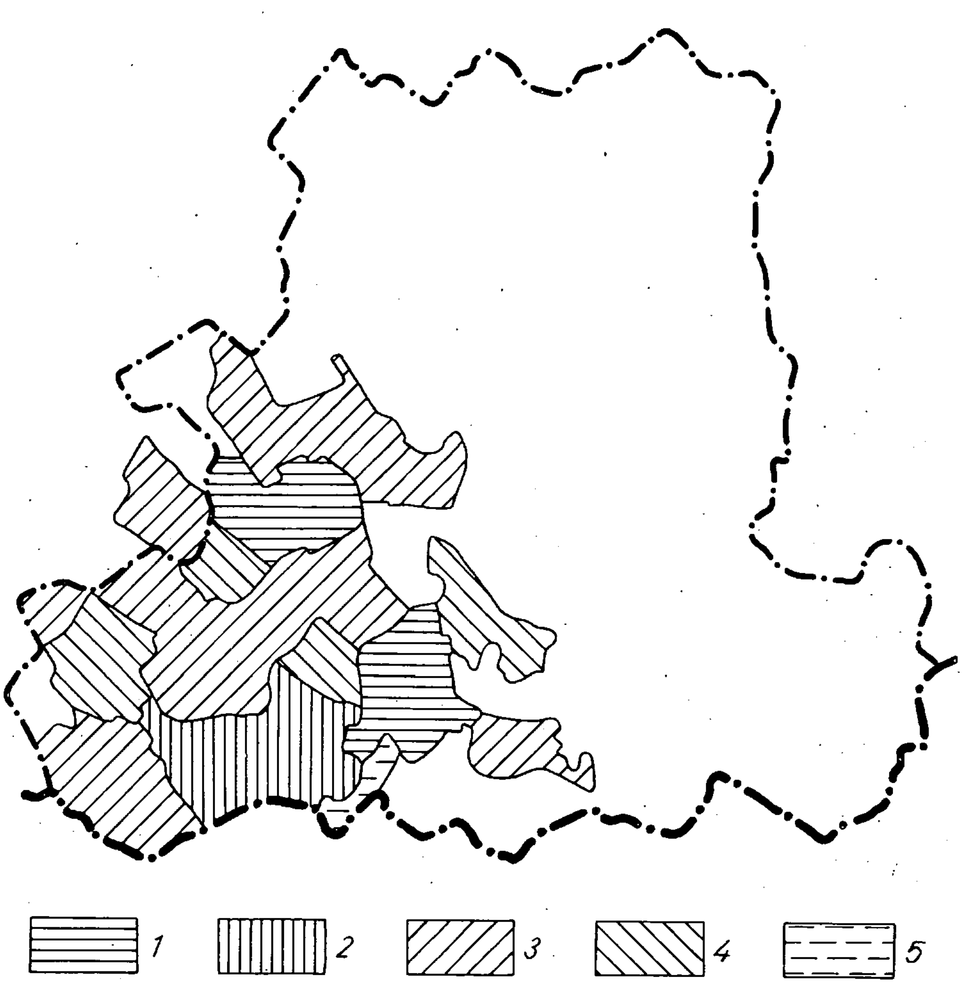
The territorial proportion of the egg supply can be explained by



15. Ft values per 1.000 persons of milk and dairy products brought to the free markets of Szeged from the different settlements.
Mean values of the different areas:
1. over 207 Ft
2. between 207—33 Ft
3. between 33—23 Ft
4. between 23— 6 Ft
5. under 6 Ft

similar causes as in the case of the milk supply. Here the difference between the zones is somewhat greater, but it does not differ essentially from the characteristic ratios of the dairy products.

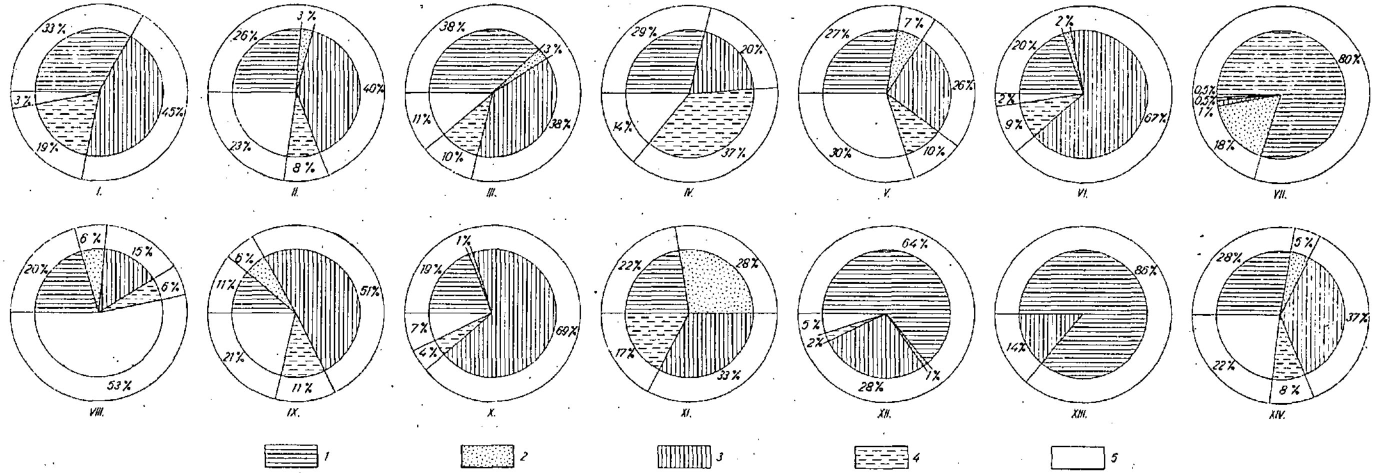
The market supply values per 1000 inhabitants only strengthen the leading position of the *inner zone*. In the case of the values calculated for 100 cadastral acres, however, Szeged takes first place (Figs. 13, 14, 15, 16, and 17. Tables 2 and 3.)



16. Ft values per cadastral acres of milk and dairy products products brought to the free markets of Szeged from the different settlements.
Mean values of the different areas:
1. over 28.1 Ft
2. between 28.1—11.1 Ft
3. between 11.1— 1.1 Ft
4. between 1.1— 0.4 Ft
5. under 0.4 Ft

The percentile market supply values per 1000 persons and 100 cad. acres of the different settlements and their distribution according to the kinds of goods are characteristic of the villages of each zone.

Fig. 18 shows these differences. At the same time the cartogram does not show the differences between the values of the supplies marketed by the different villages: so, for instance, certain settlements like Tiszasziget, Csanádpalota, Csengele, etc., fall into categories which are realistic only on the basis of the inner structure of the market supply of the villages.



17. The Ft percentage of the different goods from the various areas in the supply of the free markets of Szeged.

Signs

I. Bread crops
II. Fodders
III. Potatoes
IV. Oil seeds (sunflower)
V. Greens
VI. Grapes and other fruits
VII. Flowers
VIII. Living poultry
IX. Eggs
X. Milk and dairy products
XI. Other living animals
XII. Other animal and vegetable products
XIII. Different consumer goods
XIV. Altogether

1. Szeged
2. agglomeration zone
3. inner zone
4. outer zone
5. remoter outlying area

Table 2.

Ftfvalue pro 1000 inhabitants of the goods brought

Area, village	1	2	3	4	5	6
Agglom. zone	4	54	126,66	0,05	308,83	105
Szeged	24	110	310	0,3	269	189
Szőreg	—	99	—	—	257	28
Algyő	—	7	6	—	162	6
Gyálarét	—	—	—	—	255	178
Kiskundorozsma	—	104	214	—	344	133
Tápé	—	4	230	—	566	96
Inner zone	119,27	553,6	1066,27	1	803,63	1960,27
Zsombó	—	—	953	—	963	4162
Zákányszék	305	902	2155	—	1017	3440
Röszke	—	9	980	—	1197	744
Sándorfalva	—	57	50	—	186	150
Domaszék	131	164	1843	—	1300	4042
Deszk	863	3746	100	—	1130	24
Forráskút	—	50	2890	—	620	820
Bordány	—	95	990	—	600	933
Balástya	—	—	724	7	580	2230
Mórahalom	13	1064	790	4	767	1035
Szatymaz	—	—	254	—	480	3983
Outer zone	69,44	200,55	265,22	2,33	985,33	260,77
Üllés	—	—	—	—	—	172
Rúzsa	317	290	906	—	186	1164
Tiszasziget	3	63	2	—	29	2
Kübekháza	305	1299	—	16	2032	—
Kiszombor	—	153	62	—	333	17
Klárafalva	—	—	—	—	1661	—
Dóc	—	—	—	—	317	159
Ferencszállás	—	—	390	—	4000	—
Ásotthalom	—	—	1027	5	310	833
Remoter outlying area	0,5	21,1	98	0,3	182,5	30,45
Vésztő	—	—	—	—	—	—
Sövényháza	—	—	380	—	813	72
Pusztamérges	—	—	57	—	175	436
Öttömös	—	—	—	—	—	—
Pusztaszer	—	—	—	—	—	—
Kistelek	—	—	—	—	5	7
Kiskunmajsa	—	—	14	—	—	—
Hmvhely	—	—	—	—	2	—
Gyula	—	1	—	—	9	—
Makó	10	416	172	—	884	—
Csólyospálos	—	—	1322	7	864	90
Csanytelek	—	—	—	—	604	—
Csorvás	—	—	—	—	10	—
Csanádpalota	—	—	—	—	—	—
Csengele	—	—	—	—	30	—
Békés	—	5	—	—	5	—
Apátfalva	—	—	—	—	29	—
Maroslele	—	—	—	—	216	—
Kecskemét	—	—	15	—	3	2
Orosháza	—	—	—	—	1	—

to the market from the different villages

7	8	9	10	11	12	13	Total
105	237,83	33	8,66	0,22	12,17	1,17	996,6
99	196	12	23	0,3	45	7	1284,6
526	—	7	—	1	12	—	930
—	449	50	12	—	10	—	702
—	—	47	12	—	—	—	492
3	114	4	5	—	—	—	921
2	668	78	—	—	6	—	1650
4,54	439,54	155,44	207,09	1	55,63	32,27	5370,36
—	440	85	33	—	—	—	6636
—	1438	270	177	—	180	—	9884
45	113	92	194	—	118	—	3492
—	270	99	—	—	49	—	861
—	586	249	239	—	32	—	8586
—	165	34	66	—	18	—	6146
—	90	44	17	—	71	—	4602
—	—	37	65	—	14	—	2734
5	1020	420	1093	11	30	—	6120
—	235	212	277	—	70	—	4467
—	478	168	117	—	30	36	5546
3,66	333,77	66,88	33,22	2,11	7,88	—	2231,22
—	22	13	19	—	—	—	226
—	457	38	14	—	22	—	3394
33	638	4	—	19	46	—	839
—	—	—	—	—	—	—	3652
—	30	125	—	—	—	—	720
—	—	—	—	—	—	—	1661
—	1048	310	204	—	—	—	2038
—	390	28	—	—	—	—	4808
—	419	84	62	—	3	—	2743
1,15	222,8	28,65	18,95	—	2,35	—	606,7
—	2314	—	—	—	—	—	2314
13	33	12	67	—	—	—	1390
—	—	68	84	—	35	—	855
—	116	69	—	—	—	—	185
—	—	46	—	—	—	—	46
—	42	2	13	—	—	—	69
—	—	—	—	—	—	—	14
—	109	29	—	—	—	—	136
—	388	—	—	—	—	—	398
—	5	5	—	—	1	—	1493
10	432	317	215	—	—	—	3257
—	—	4	—	—	—	—	608
—	—	—	—	—	—	—	10
—	—	11	—	—	—	—	11
—	—	10	—	—	—	—	40
—	1018	—	—	—	—	—	1028
[illegible]	—	—	—	—	8	—	37
—	—	—	—	—	—	—	216
—	—	3	—	—	3	—	26
—	—	—	—	—	—	—	1

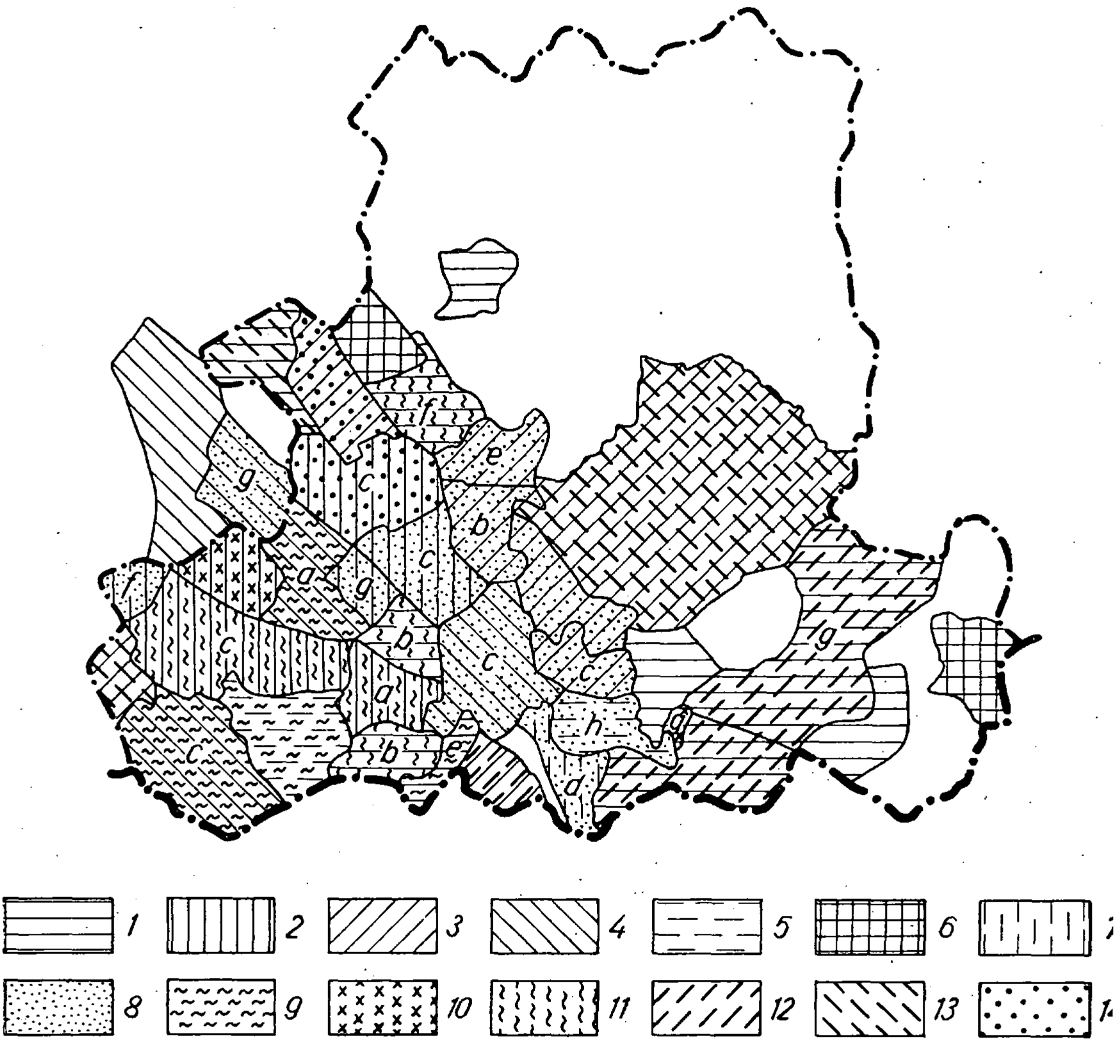
3. *Table*

Ft value per 100 cadastral acres of goods brought

Area, village	1	2	3	4	5	6
Agglomeration zone	—	7,2	15,1	—	35,9	9,7
Szeged	29,1	131,6	368,7	0,4	319,4	224,4
Szőreg	—	9,5	—	—	24,7	2,6
Algyő	—	0,5	0,4	—	10,9	0,4
Gyálarét	—	—	—	—	4,4	3,0
Kiskundorozsma	—	25,9	53,6	—	86,2	33,5
Tápé	—	0,4	21,8	53,6	9,0	0,1
Inner zone	6,2	21,7	67,2	0,03	54,1	130,8
Zsombó	—	—	74,8	—	75,6	326,9
Zákányszék	14,6	43,3	103,5	—	48,8	165,1
Röszke	—	0,8	86,9	—	106,4	66,1
Sándorfalva	—	6,9	6,0	—	22,6	18,2
Domaszék	7,9	9,9	111,0	—	83,2	243,5
Deszk	45,3	196,5	5,2	—	59,3	1,2
Forráskút	—	3,0	170,2	—	36,4	48,2
Bordány	—	7,1	73,9	—	45,0	69,7
Balástya	—	—	34,3	0,1	27,5	105,7
Mórahalom	0,8	71,9	53,2	0,3	51,8	69,9
Szatymaz	—	—	20,7	—	38,9	324,6
Outer zone	3,2	8,7	17,2	0,08	76,1	13,9
Üllés	—	—	—	—	—	11,9
Rúzsa	16,5	15,0	47,1	—	9,6	60,5
Kübekháza	12,5	53,2	—	0,6	83,7	—
Tiszasziget	0,1	2,9	0,1	—	1,3	0,1
Kiszombor	—	7,6	3,0	—	16,5	0,8
Klárafalva	—	—	—	—	93,8	—
Dóc	—	—	—	—	7,5	3,8
Ferencszállás	—	—	44,3	—	454,5	—
Ásotthalom	—	—	60,3	0,2	18,1	48,8
Remoter outlying area	0,04	2,0	4,9	0,01	12,7	2,3
Vésztő	—	—	—	—	—	—
Sövényháza	—	—	19,7	—	42,2	3,7
Pusztamérges	—	—	4,9	—	15,1	37,7
Öttömös	—	—	—	—	—	—
Pusztaszer	—	—	—	—	—	—
Kistelek	—	—	—	—	0,6	0,8
Kiskunmajsa	—	—	1,2	—	—	—
Hódmezővásárhely	—	—	—	—	0,1	—
Gyula	—	0,1	—	—	1,2	—
Makó	0,9	40,8	16,8	—	86,7	—
Cyólyospálos	—	—	50,7	0,3	33,1	3,4
Csanytelek	—	—	—	—	61,7	—
Csorvás	—	—	—	—	0,5	—
Csanádpalota	—	—	—	—	—	—
Csengele	—	—	—	—	1,5	—
Békés	—	0,1	—	—	1,2	—
Apátfalva	—	—	—	—	1,7	—
Maroslele	—	—	—	—	7,7	—
Kecskemét	—	—	4,3	—	0,9	0,5
Orosháza	—	—	—	—	0,1	—

to the market from the different villages

7	8	9	10	11	12	13	Total
10,2	24,4	2,6	0,4	0,2	0,4	—	106,1
118,0	233,6	14,9	28,1	0,4	54,0	8,6	1531,2
50,5	—	0,7	—	0,9	1,1	—	90,0
—	30,3	3,3	0,8	—	0,7	—	47,3
—	—	0,8	0,2	—	—	—	8,4
0,7	28,6	1,0	1,1	—	—	—	230,6
63,2	7,4	—	—	—	0,5	—	156,0
0,3	27,1	9,9	11,1	0,04	3,7	0,2	332,37
—	34,6	6,6	2,5	—	—	—	521,0
—	69,0	13,0	8,5	—	8,5	—	474,3
4,0	10,0	8,1	17,3	0	10,4	—	310,0
—	32,9	12,0	—	—	5,9	—	104,5
—	35,3	15,0	14,4	—	1,9	—	522,1
—	8,6	1,8	3,5	—	0,9	—	322,3
—	5,3	2,6	1,0	—	4,2	—	270,9
—	—	2,8	4,8	—	1,0	—	204,3
0,2	48,4	19,9	51,8	0,5	1,4	—	289,8
—	15,8	14,3	18,6	—	4,7	—	301,3
—	38,9	13,7	9,5	—	2,5	2,9	451,7
0,1	16,7	2,7	1,1	0,1	0,3	—	140,18
—	1,5	0,8	1,3	—	—	—	15,5
—	23,7	2,0	0,7	—	1,1	—	176,2
—	—	—	—	—	—	—	150,0
1,5	30,0	0,1	—	0,9	2,1	—	39,1
—	1,4	6,2	—	—	—	—	35,5
—	—	—	—	—	—	—	93,8
—	24,9	7,3	4,8	—	—	—	48,3
—	44,3	3,1	—	—	—	—	546,2
—	24,6	4,9	3,6	—	0,1	—	160,6
0,05	18,1	1,4	1,0	—	0,2	—	42,7
—	141,5	—	—	—	—	—	141,5
0,6	1,7	0,5	3,4	—	—	—	71,8
—	—	5,8	7,3	—	3,0	—	73,8
—	6,6	4,0	—	—	—	—	10,6
—	—	2,0	—	—	—	—	2,0
—	5,4	0,3	1,6	—	—	—	8,7
—	—	—	—	—	—	—	1,2
—	9,0	2,1	—	—	—	—	11,2
—	49,5	—	—	—	—	—	50,8
—	0,4	0,5	—	—	0,1	—	146,2
0,4	16,5	12,1	8,2	—	—	—	124,7
—	—	0,3	—	—	—	—	62,0
—	—	—	—	—	—	—	0,5
—	—	0,5	—	—	—	—	0,5
—	—	0,5	—	—	—	—	2,0
—	130,3	—	—	—	—	—	131,6
—	—	—	—	—	0,5	—	2,2
—	—	—	—	—	—	—	7,7
—	—	0,8	—	—	0,7	—	7,2
—	—	—	—	—	—	—	0,1



18. The share of the three leading groups of commodities in the total market supply of the settlements calculated for 1.000 persons or 100 cadastral acres of plowland.

Signs

1. Sign of the group of commodities in the first place	2. Sign of the group of commodities in the first place	3. Sign of the group of commodities in the third place.
1 greens	8 greens	a greens
2 fruits, grapes	9 fruits, grapes	b fruits, grapes
3 living poultry	10 living poultry	c living poultry
4 potatoes	11 potatoes	d fodders
5 fodders	12 fodders	e eggs
6 eggs	13 eggs	f dairy products
7 flowers	14 flowers	g potatoes
		h bread crops

II.

The zones of the (daily) free markets of Szeged and the structure of their goods supply

Besides Szeged's own internal supply its (daily) markets are supplied with goods from four other areas. Fig. 19.

The average value per market day ot the total supply brought to market on market days was 564.702 Ft; 37% of this came from the so-called *inner zone,* 28% from the vicinity of *Szeged,* 22% from the remoter outlying area, the so-called *scattered* market areas, 8% from the *outer* zone, and 5% from the *agglomeration* zone.

The most important supplier of the daily markets of Szeged is, on the basis of percentile contribution, the *inner zone.* It takes absolutely first place in fruit, grape, milk, dairy goods, egg, fodder, bread crop and live animal supply. In the potato supply it shares the first place with Szeged although surpasses it with a 1000 Ft value of goods. In respect of the supply of animal or vegetable products as well as other commodities it is second after Szeged. It hoods the third place in regard of the supply of several products such as live poultry, greens, flowers and sunflower seeds.

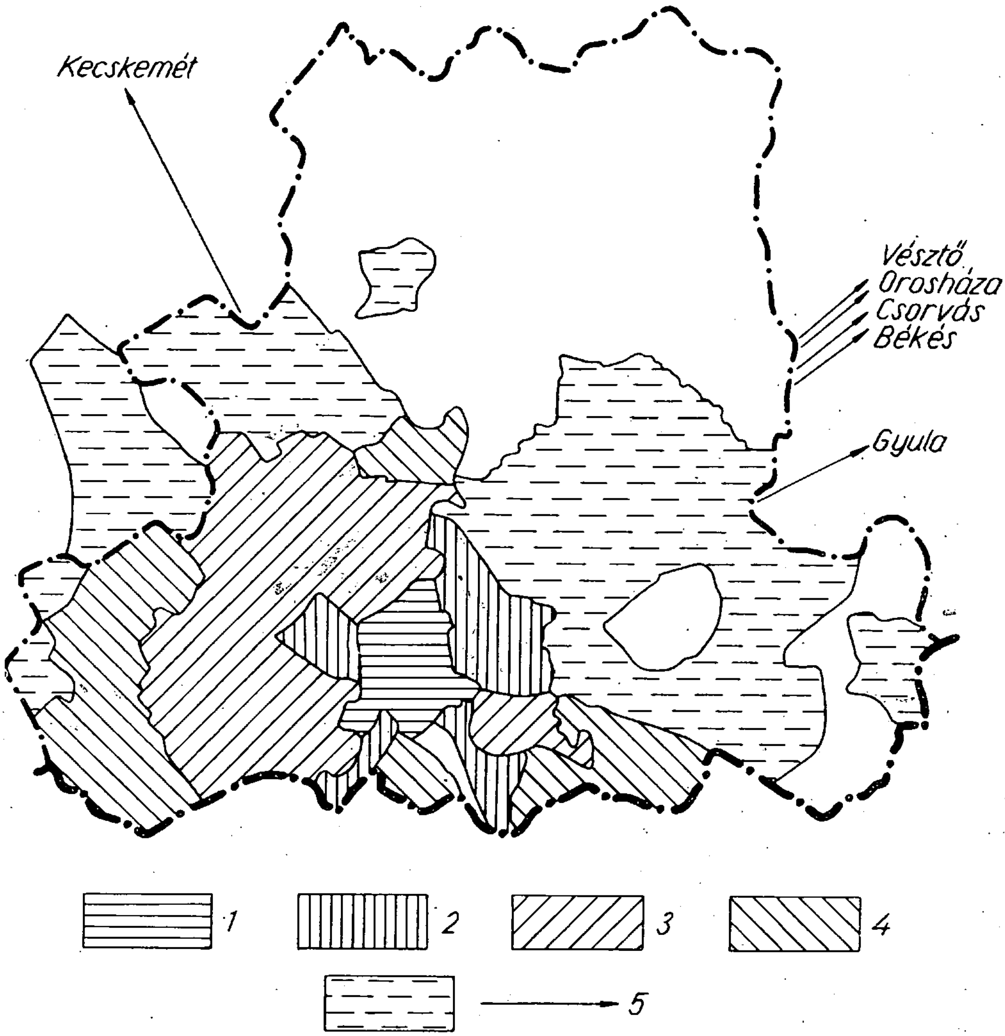
The value of the average market supply of the *inner zone* (on one market day) is 210.360 Ft. Owing to its inner structure of goods it brings the largest amounts of grapes and fruit to the markets of Szeged. These represent 36% of the amount of goods on the market. After them come potatoes with 18% and greens with 14.5%. Fodders come in the fourth place with 10%.

This zone is, on the basis of its supply of goods, the *fruit, grape, potato, greens, and fodder supplier of Szeged.* This character of it is completed with its supply of live poultry (8.5%) and dairy products (5%). Its supply of other goods is unimportant in spite of the fact that in respect of the supply of eggs and live animals other than poultry and bread crops it holds the first place and in respect of some other goods the second place.

This character of the market supply of this zone agrees with its agricultural production structure.

The leading position of the inner zone in the supply of the markets of Szeged is due to various factors:

1. its distance from Szeged is favorable; even its remotest village is not farther away than 25 km and so the town can be reached from it in one or one and a half hours even with the slowest conveyance (horse carriage);
2. all of its villages are connected with Szeged by highways (from some settlements the market can be reached by narrow-gauge railway);
3. the distribution of the population according to professions is favorable. A relatively great number of the population are peasants



19. Areas of the free markets of Szeged

Signs

1 Szeged
2 agglomeration zone
3 inner zone
4 outer zone
5 remoter outlying zones

by profession and their decrease in number is slower than in the agglomeration zone.

According to its supply of 156.453 Ft in value Szeged *holds* the second place among the zones.

Within its own supply potato is at the top with 24%, then come greens with 21%. On account of its large amounts poultry is the third in order; then come grapes and fruits, fodders and flowers. The flower demand of the markets of Szeged is nearly exclusively satisfied by Szeged itself. Greens also play an important role in the self-supply of the town. Potatoes, poultry, grapes and fruit come only after these.

On the basis of the goods brought to the market the town of Szeged can be said to be the supplier of its own markets of *greens, flowers, potatoes, poultry, grapes and other fruits.*

In comparison with the other areas the town of Szeged takes second place in the supply of its own markets with a contribution of 28% which is natural because it is the agricultural population in the territory and vicinity of the town that feels the demand of the markets best and at the same time their transport facilities and distances are the most favorable.

The town ensures itself a leading position among the areas in respect of the products meaning the greatest specialization. So it is absolutely first in the supply of flowers, animal and vegetable products, and various articles of consumption. It shares the first place in greens and potato supply with the *remoter outlying area* as well as with the *inner zone.* It is second in the supply of grapes, fruits, poultry, milk and dairy products, fodders and sunflower seeds. It is third in the percentile participation of the areas in supply, namely in the supply of other live animals and eggs.

In the comparison of the supplying zones the agglomeration zone of Szeged falls to the last place in respect of total market supply with a contribution in the value of 26.874 Ft. This zone is, from the point of view of the number of inhabitants the most vigorously growing area of the town, therefore the demands also grow here most rapidly. From this it follows that it cannot contribute to the supply of Szeged with considerable amounts of most products. It has second place among the areas only in the supply of flowers and animals other than poultry. It figures with greens in the supply of the markets of Szeged with 33%; then comes the supply of poultry with 26%, potatoes with 12.5, and flowers with 10%. In its internal structure of goods the flower supply is represented with a larger percentage than in the case of Szegel, and the supply of greens, too; in this respect it holds the first place. It is second, we say, in the supply of poultry on the basis of its internal structure.

The position of the agglomeration zone in the supply of Szeged is determinded by the following facts:

1. The so-called agglomeration zone of Szeged has grown to Szeged relatively rapidly, in the last 10 years. During this time its population has grown and has been reorganized more rapidly than that of the town itself.

A large part of its population has been employed in the industry and as such has appeared as a new layer of buyers. Thus a large part of the earlier surplus products are bought up locally.

2. The special structural change in agriculture has not been able to keep pace with the rapid transformation (growth and reorganization of

the population, rapid growth of the number of those employed in industry); therefore it has fallen behind in its accomodation to the more favorable market conditions.

Of course not all settlements of the agglomeration zone have developed at the same rate. There are therefore rather considerable differences between then.

a) *Kiskundorozsma* sends its goods to the markets of Szeged, yet it cannot meet the demand of its own free market. Its internal market supply is scarcely more than 19%. So 81% of the goods brought to its market come from immediately neighboring settlements, Kiskundorozsma contributes chiefly live poultry, greens and potatoes to the daily market trade of Szeged.

b) *Algyő* had been producing its own (daily) supply requirement (of market goods) until the opening up of the oil fields near Szeged, but now it cannot satisfy the suddenly increased number of workers. Therefore Algyő also appears in the markets of Szeged as purchaser. It has a surplus only in earlier strongly specialized goods as live poultry, greens, and eggs.

c) *Tápé, Szőreg, Gyálarét* are self-suppliers even now for various market products, but for some products they are, like Szeged, buyers.

Szőreg is an important flower and green supplier of the market of Szeged but among its goods brought to the market only the fodder crops deserve to be mentioned.

Tápé is important as a poultry and green supplier, though its potato supply is not inconsiderable either. It supplies also a substantial amount of eggs.

Gyálarét is first of all a green supplier, but its fruit and egg supply is also important enough. Szeged and its *agglomeration zone* can satisfy the daily demand of Szeged's markets even together only in part (one third). Two thirds of the goods are supplied by the *inner zone* and the expansive *outer* and *remoter outlying* areas.

The percentile contribution of the *outer zone* (to the daily market supplies Szeged) is in agreement with its location. It is true that the situation of these settlements from the point of view of transport facilities is really not worse than that of the remotest villages in the inner zone, but in places their physical geographical conditions are more unfavorable. In the case of these villages the sending of supplies to the markets of Szeged is unfavorably influenced also by the diverting and attracting effect of other markets. Their goods are distributed between different markets.

It follows from their respective distances that the structure of their agriculture feels and follows the indirect effect of the market but slowly. They sell the large amounts of their surplus products at the local purchasing stations. This zone is rather the supplier of purchasing companies and industrial establishments in Szeged. From this it follows that in a comparison of the market-supplying activities of the various areas this zone takes the first place only in the supply of sunflower seeds. In grape, fruit, bread crop, and egg supply it occupies only the third place.

Investigation of the structure of the internal supply is especially important in the case of this zone because its role in supplying the market of Szeged is easier to judge in this way. In the internal structure of its marketed supply this zone has given a large contribution in greens which was 25% of the total value. The contribution of fruits and grapes was 21%, that of potatoes 21%. As a complementary good, poultry is in the fourt place with 14.5%. Fodders represent 8.5% and eggs 3.5%. Regarding its internal structure its marketed egg supply is larger than that of the other areas. On the basis of the internal structure of the zone we may state that it is the *grape, fruit, potato, green, poultry, fodder and egg supplier of Szeged.*

The remoter outlying area comprises partly settlements in Bács-Kiskun county (Csólyospálos, Kiskunmajsa), partly Makó and its neighborhood as well as the district of Kistelek and a few remoter settlements. It is true that generally appear in the markets of Szeged only with one or two kinds of products but with large quantities. This area holds the third place with a marketed value of 124.776 Ft among the supply zones. It holds the first place in poultry supply. In green it shares the first place with Szeged. It is second in egg supply, while in the supply of fodder, potatoes, dairy products and other vegetable and animal products it holds the third place.

In the internal structure of the area live poultry is at the top with 48.5%, followed by greens with 27.5%, fodders with 10%, and potatoes with 8.5%. The internal market supply structure of the area is in agreement with its agricultural production structure, although poultry raising is by far not so important here as shown by its percentile contribution to the market supply.

This area is the *poultry, green, fodder and potato supplier* of Szeged.

Similarly as in the other areas, here too, various territorial types can be distinguished on the basis of the marketed goods:

a) Makó and its environs besides supplying their own market appear not only in Szeged with their goods but also in Hódmezővásárhely and Orosháza.

b) Kiskunmajsa, besides supplying its own market, sends products to Szeged but so does Kiskunhalas too, while Csólyospálos is more attracted by Szeged than by Kiskunmajsa.

c) Kistelek itself, on account of its large market hardly sends any goods to Szeged; on the other hand, its environs appear with larger amounts of goods at the markets of Szeged.

(Table 4, Fig. 20)

Summing up:

On the basis of the daily market supply the following supply zones have developed around Szeged:

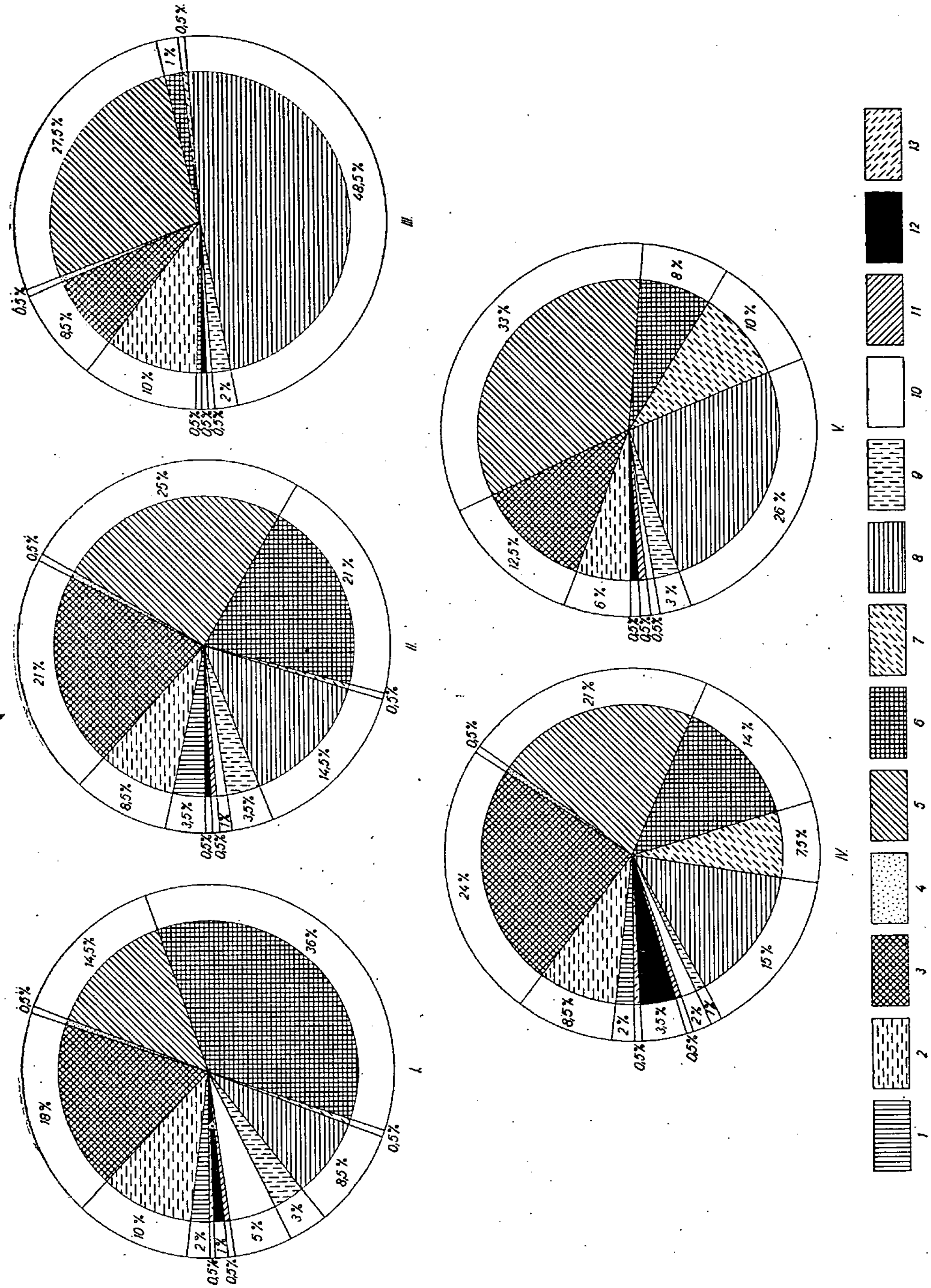
4. *Table*

Contribution of the different villages to the supply of the market of Szeged in Ft % Share of the different foods in the market supply of the different areas in Ft %

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Bread crops	Fodders	Potatoes	Sun-flower	Greens	Fruits	Floers	Poultry	Eggs	Dairy pro-ducts	Ani-mals ot-her than poultry	Other an and veg. prob.	Other cons. goods	Total
Szeged	33 2978 2	26 13446 8,5	38 37663 24	29 40 0,5	29 32627 21	20 22928 14	80 12056 7,5	20 23866 15	11 1532 1	19 2877 2	22 40 0,5	65 5521 3,5	86 87 9 0,5	28 156453 100
Agglomeration zone	—	3 16122 5	3 3384 12,5	—	7 8784 33	2 2140 8	18 2686 10	6 7162 26	6 790 3	1 124 0,5	28 50 0,5	1 142 0,5	—	5 26874 100
Inner zone	45 4045 2	40 21245 10	38 38618 18	20 28 0.5	26 31324 14,5	68 75862 36	1 205 0,5	16 18865 8,5	51 7244 3	69 10348 5	33 60 0,5	28 2370 1	14 148 0,5	37 210360 100
Outer zone	19 1670 3,5	8 4011 8,5	10 9764 21	37 52 0,5	9 11611 25	9 9858 21	0,5 52 0,5	6 6717 14,5	11 1620 3,5	4 688 1	17 30 0,5	2 166 0,5	—	8 46239 100
Remoter outlying area	3 290 0,5	23 12345 10	11 11013 8,5	14 20 0,5	29 34722 27,5	1 1351 1	0,5 56 0,5	52 60642 48,5	21 3012 2	7 992 0,5	—	4 333 0,5	—	22 124776 100
Total	100 8981 1,6	100 52659 9,3	100 100 442 17,8	100 140 0,02	100 119 068 21,1	100 121 139 19,8	100 15055 2,7	100 117252 20,8	100 14198 2,5	100 15029 2,7	100 180 0,03	100 8532 1,5	100 1027 0,2	100 564 702 100

Table 5.
Percentile contribution of the different villages to the total market supplly of Szeged

Area, village	Ft value	Percentile contribution of settlements	Percentile contribut on of areas
Szeged	156 453	28,0	28
Agglom. zone			
Szőreg	4 726	0,8	
Algyő	4 030	0,7	
Gyálarét	332	0,1	5
Kiskundorozsma	9 338	1,7	
Tápé	8,448	1,5	
Inner zone			
Zsombó	13 015	2,3	
Zákányszék	31 669	5,6	
Röszke	13 499	2,4	
Sándorfalva	2 036	0,9	
Domaszék	31 056	5,5	
Deszk	17 893	3,1	37
Forráskút	10 820	2,0	
Bordány	7 573	1,3	
Balástya	31 467	5,6	
Mórahalom	25 612	4,5	
Szatymaz	22 720	4,0	
Outer zone			
Üllés	755	0,1	
Rúzsa	12 446	2,2	
Tiszasziget	1 316	0,2	
Kübekháza	5 987	1,0	8
Kiszombor	3 391	0,6	
Klárafalva	1 000	0,2	
Dóc	2 238	0,4	
Ferencszállás	3 448	0,6	
Ásotthalom	15 658	2,7	
Remoter outlying area			
Vésztő	22 484	3,9	
Sövényháza	3 321	0,6	
Pusztamérges	1 463	0,3	
Öttömös	224	0,1	
Pusztamérges	100	0,1	
Kistelek	603	0,1	
Kiskunmajsa	175	0,1	
Hódmezővásárhely	7 184	1,3	
Gyula	9 971	1,7	
Makó	44 200	7,8	22
Csólyospálos	8 705	1,5	
Csanytelek	2 330	0,4	
Csorvás	73	0,1	
Csanádpalota	52	0,1	
Csengele	127	0,1	
Békés	21 019	3,7	
Apátfalva	182	0,1	
Maroslele	492	0,1	
Kecskemét	2 039	0,3	
Orosháza	32	0,1	
Total	564 702	100 0	100



1. *inner:* flower, green, poultry, supplying-potato zone,
2. *intermediate:* grape, fruit, green. potato, dairy product, egg-supplying zone,
3. *transitional:* grape, fruit, green, potato, fodder, breadcrop-supplying zone, and
4. *outer:* green, poultry, egg and fodder-supplying zone.

(Tables 5 and 6, Figs, 21 and 22.)

20. The Ft % share of the different commodities in the total supply of the free markets of Szeged.

Signs

1 bread crops
2 fodders
3 potatoes
4 oil seeds (sunflower)
5 greens
6 fruits
7 flowers

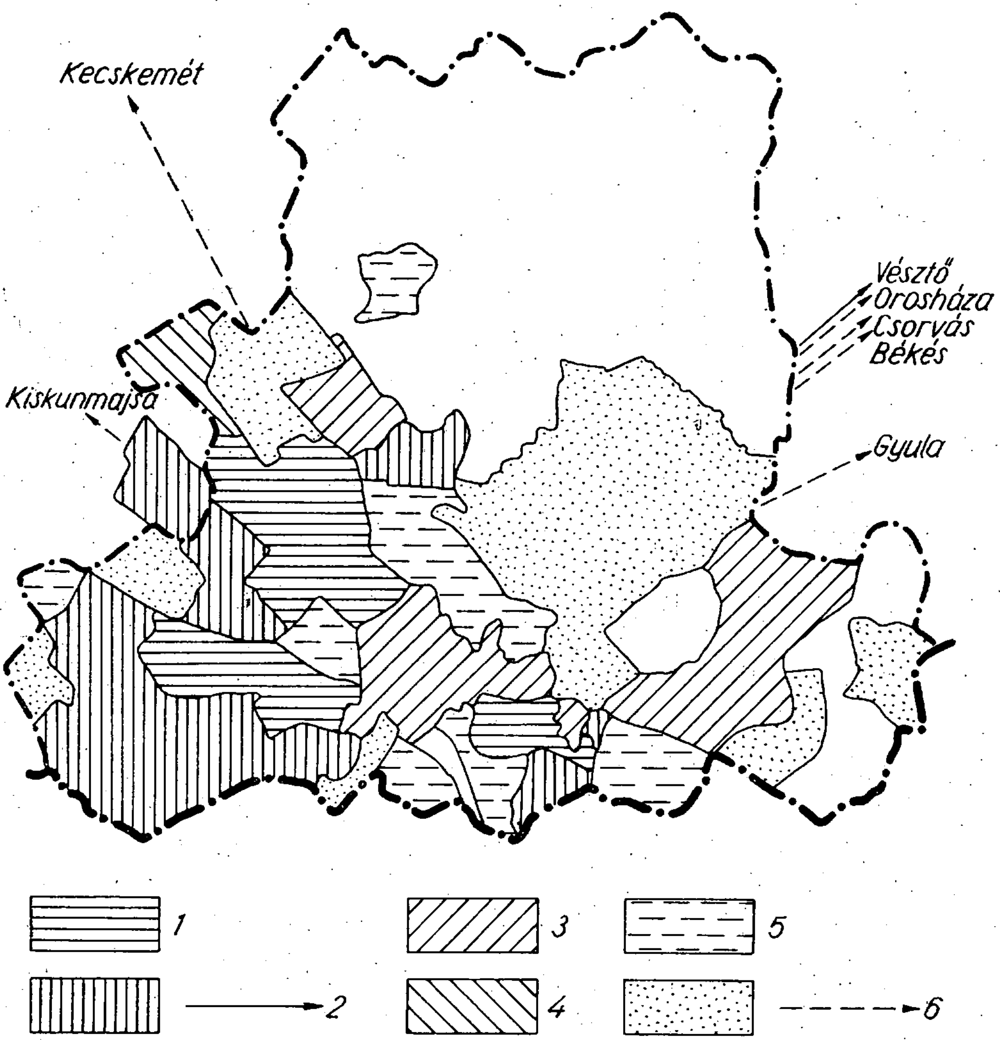
8 living poultry
9 eggs
10 dairy product
11 living animals other than poultry
12 other animal and vegetable products
13 different consumer goods

I inner zone
II outer zone
III remoter outlying areas
IV Szeged
V agglomeration zone

Table 6.

Ft % contribution of the villages within the areas to the total market supply of the area

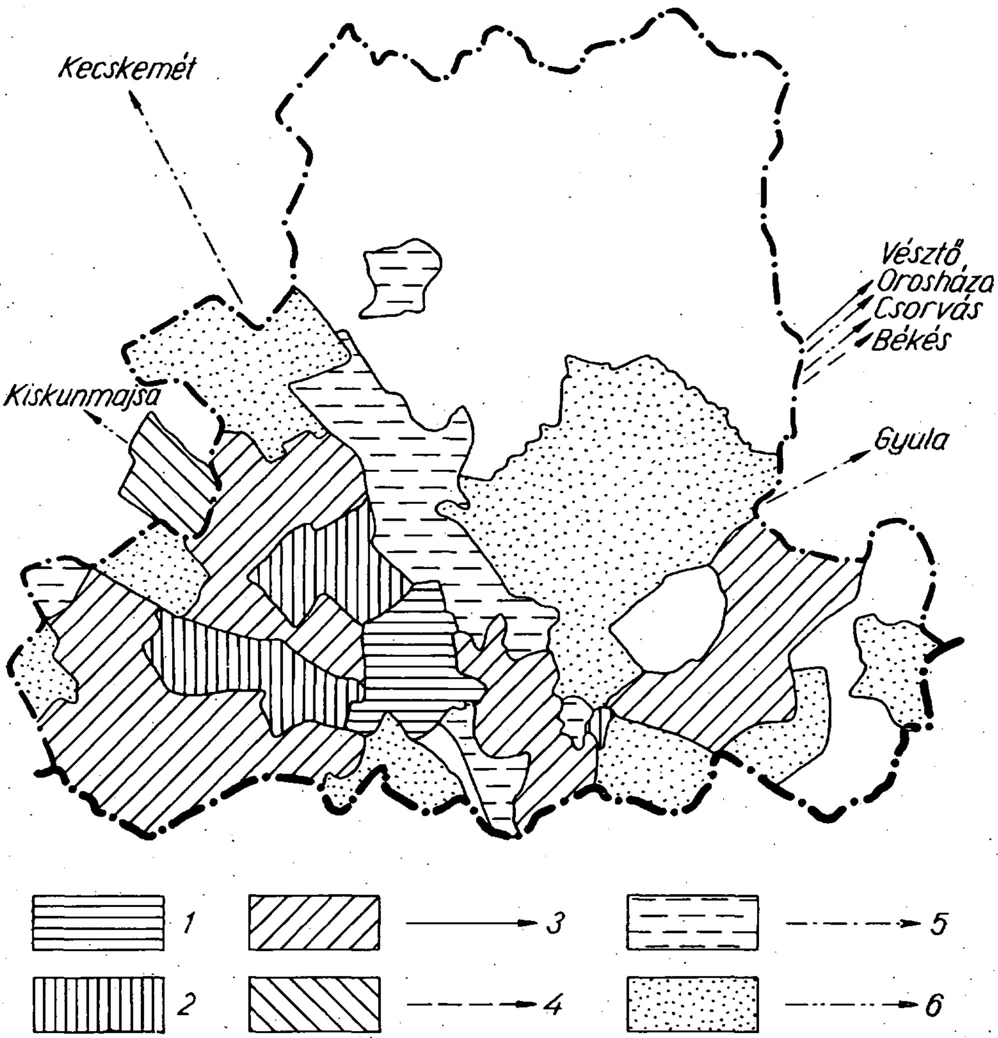
Serial number	Area, village	Ft value	Percentile contribution of the settlements within the areas
	Agglomeration zone		
1	Szőreg	4 726	18
2	Algyő	4 030	15
3	Gyálarét	332	1
4	Kiskundorozsma	9 338	35
5	Tápé	8 448	31
		Total 26 874	100
	Inner zone		
1	Zsombó	13 015	6
2	Zákányszék	31 669	15
3	Röszke	13 499	6
4	Sándorfalva	5 036	2
5	Domaszék	31 056	15
6	Deszk	17 893	9
7	Forráskút	10 820	5
8	Bordány	7 573	4
9	Balástya	31 467	15
10	Mórahalom	25 612	12
11	Szatymaz	22 720	11
		Total 210 360	100
	Outer zone		
1	Üllés	755	2
2	Rúzsa	12 446	27
3	Tiszasziget	1 316	3
4	Kübekháza	5 987	13
5	Kiszombor	3 391	7
6	Klárafalva	1 000	2
7	Dóc	2 238	5
8	Ferencszállás	3 448	7
9	Ásotthalom	15 658	34
		Total 46 239	100
	Remoter outlying areas		
1	Vésztő	22 484	18
2	Sövényháza	3 321	2
3	Pusztamérges	1 463	1
4	Öttömös	224	0,5
5	Pusztamérges	100	0,5
6	Kistelek	603	0,5
7	Kisffunmajsa	175	0,5
8	Nódmezővásárhely	7 184	5,5
9	Gyula	9 971	7,5
10	Makó	44 200	35
11	Csolyóspálos	8 705	6,5
12	Csanytelek	2 330	2
13	Csorvás	73	0,5
14	Csanádpalota	52	0,5
15	Csengele	127	1
16	Békés	21 019	16
17	Apátfalva	182	0,5
18	Maroslelle	492	1
19	Kecskemét	2 039	0,5
20	Orosháza	32	0,5
		Total 124 776	100



21. Ft value per 1,000 persons of the total of goods brought to the free markets of Szeged from the different settlements.

Mean values of the different areas:

1. over 5370 Ft
2. between 5370—2231 Ft
3. between 2231—1284 Ft
4. between 1284— 996 Ft
5. between 996— 606 Ft
6. under 606 Ft



22. Ft value per 100 cadastral acres of the total of goods brought to the free markets of Szeged from the different settlements.

Mean values of the different areas:

1. over 1531 Ft
2. between 1531—343 Ft
3. between 343—140 Ft
4. between 140—106 Ft
5. between 106— 43 Ft
6. under 43 Ft

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DELIMITATION OF THE ATTRACTION AREAS OF CENTRES OF THE SOUTHERN GREAT PLAIN ON THE BASIS OF LONG-DISTANCE CALLS

BY J. TÓTH

I. Introduction

Of late years, more studies have been published, which attempted to delimit the attraction area of the centres of the Southern Great Plain, or which were in close connection with the research of attraction area. These studies dealt with the attraction areas of manpower of the towns of the Southern Great Plain (Tóth, 1966), with the sudden expansion of the attraction area of Szeged in the sixties, (Krajkó—Tóth, 1969), the attraction areas of public health centres, (Pénzes—Tóth, 1970), and education centres (Tóth—Pénzes, 1970) of the Southern Great Plain, with the areas of goods supply of free market centres of Csongrád county (Pénzes—Tóth—Abonyiné, 1969) and with the delimitation of those suburban areas, in which the effect of the centres on change of population number, can be shown.

On the basis of our relatively comprehensive — though by no means completed — investigations, the attraction areas of the centres of the Southern Great Plain can already be delimited with reliability. So we have a possibility of good control, concerning the applicability, the exactness of the different methods, to be applied to the researches of attraction area. The aim of this study is — beside the conrete results — to present a method, which leads to an approximately correct result, despite of its apparent onesidedness, and which can be utilized usefully, combined with other methods in the researches of attraction area.

Method of the research

It is not a recent method to utilize the data related to the network of telephones in the investigations of settlement geography. In his debated study, treating the geometrical pattern of the „central places", Christaller took the number of telephone connections as basis (Christaller, 1933). Neef repeated Christaller's investigationson the territory of Saxony (Neef, 1950). In Hungary, Tibor Mendöl used similar data in 1944, investigating the validity of Christaller's theory among Hungarian circumstances (Mendöl, 1963). In the researches of attraction areas — to the best of our knowledge — till this time only Rozalia Éliás applied the data relating to the network of telephones, delimiting the attraction areas according to the number and proportion of the long-distance calls started from the centre (Éliás, 1954.)

We have deviated from the method, used by Éliás, so far as we have extended the area of investigation to the whole Southern Great Plain, on the one hand, enabling the attraction areas of the individual centres to be delimited in such a way, and we took for a basis the calls, starting from the communes towards the centre, instead of the long-distance calls of the centre. According to our opinion, this method serves better the purpose, and it can be utilized better to class a commune and to measure how intensely is it bound to the centre.

From the Post Office of Szeged, we have received the average monthly calls for the year of 1968, according to the communes, of the Southern Great Plain, and the list of the five localities called the most frequently together with the number of calls directed towards them. We have treated the material in such a way, that we have determined the centres by the absolute number of calls and the number of communes bound to them, then we have delimited zones according to the absolute or the relative majority of longdistance calls of the communes directed to the centres. Here, and at the delimitation of the attraction area of the individual centres, we have followed the adminisrative commune boundaries.

III. Results of the research

On the basis of the hierarchy of calls and the numbers of the attracted communes, attraction centres, partial centres and sub-centres can be delimited (Figure 1.)

1. *Attraction centres*

Attraction centres are 20 in number. They comprise towns of the Southern Great Plain and 6 small towns of commune rank which are district centres even today (Kiskőrös, Szeghalom, Békés) or they have lost this function of public administration in the recent past (Bácsalmás, Gyoma, Sarkad). The number of calls is high in attraction centres (monthly average: 3—40 thousands) and an extensive attraction area belongs to eash of them.

Its number of population, — aside from Hódmezővásárhely, being in exceptional situation — alternates from 10.000 to 110.000, and it numbers 4 to 30 communes.

a) The number of the first-order centres is four. They are the only centres on the Southern Great Plain, that are bound to Budapest directly, on the basis of the most calls. Among them the greatest is Szeged to which 22 communes are bound with the absolute majority of calls, and 8 communes with the relative majority of calls. (Table 1.) Apart from berti) the other communes of Csongrád County are also strongly attracted by Szeged: after the local centre, the most longdistance calls of this area are directed to Szeged as well.

The attraction area of Kecskemét extends over the boundaries of Kecskemét district. From the Dunavecse district Szabadszállás, from the Kiskőrös one, Fülöpszállás are attracted by the town. Kecskemét is the

second largest centre of the Southern Great Plain, considering both the population of the attraction centre, the number of the attracted communes and the number of calls. Its attraction, overlapped by the local centres, extends to the total two-thirds of Bács-Kiskun County, northwards from the Kalocsa—Kelebia line.

The third County seat Békéscsaba has particular position owing to the specific configuration of the centres of Middle Békés, and to the functional division of labour among them. With the exception of the northern and the southern confines of the county, its overlapped attraction extends over the whole area of Békés County, and it distinguishes itself by the number of calls but its direct attraction area is comparatively small: 8 communes with about 30.000 inhabitants. This area is also cut in two by the inserted attraction area of Békés commune. Eastwards, the attraction of Gyula, a district seat, performing a lot of county activities, however, is stronger (Békéscsaba is not a centre of district).

Baja is the second centre of the Southern Great Plain, considering the number of communes attracted by it, with the absolute majority of calls, the third, considering the number and the population of the attraction area, and the fourth on the basis of the number of the calls. In consequence of the large extension of Bács-Kiskun County and the peripheral position of the county seat, the overlapped attraction of Baja can be felt, up to the Kalocsa—Kelebia line as against Kecskemét, so the town can be considered the second county seat, practically.

Table 1. *Data of the first-order attraction centres*

Attraction centre	Monthly average number of calls (1000)	Number of calls directed to Budapest (%)	Number of communes			Number of population of the attraction area (1000)
			with the absolute majority of calls	with the relative majority of calls	with transposition	
Szeged	40,0	22,1	22	8	—	108,9
Kecskemét	34,1	20,0	10	10	—	91,5
Békéscsaba	19,1	20,6	3	5	—	30,1
Baja	15,8	16,6	14	3	—	44,7

b) The second-order centres are not bound directly to Budapest any more. Their attraction area and the number of calls are much smaller, they do not or hardly show an overlapping attraction, so their delimitation from the above group does not give rise to difficulties. They are 9 in number, (Table 2.) Hódmezővásárhely exceeds them in long-distance calls, but its attraction area — beyond its large fields — is limited to two communes only. In consequence of its particular position — its vicinity to Szeged, its lack of district functions etc. — it is the single second-order attraction centre, to which no commune is bound with the absolute majority of calls. The other second-order centres represent the same level, essentially, considering both the number of calls (from 7.1 to 11.9 thousand), the attracted communes (from 6 to 16), and the population of the attraction area (from 22 to 44 thousands). It must be mentioned that Kiskőrös commune is equal in rank with a town.

Table 2.

Data of the second-order attraction centres

Attraction centre	Monthly average number of calls (1000)	Number of communes			Number of population of the attaching area (100)
		with the absolute majority of calls	with the relative majority of calls	with transposition	
Hódmezővásárhely	14,0	—	2	—	5,2
Orosháza	11,9	6	3	1	41,2
Szentes	11,3	3	7	—	29,6
Kalocsa	10,1	5	10	—	30,7
Kiskunhalas	9,7	4	6	2	44,0
Kkfélegyháza	9,4	4	5	2	38,4
Makó	8,8	6	9	1	28,9
Gyula	8,5	3	3	—	21,7
Kiskőrös	7,1	4	6	2	39,7

c) Two of our actual and three of our former district seat communes, and two of our towns with smaller attraction areas are classed among the third-order centres. (Table 3.) As compared with the previous group, their characteristics are of less value, but they are the centres of a comparatively large number of communes, centres of the population of an extended attraction area. Their connections with the first-order centres — as contrasted with the partial ones — are direct and unambigoous.

Table 3.

Data of the third-order attraction centres

Attraction centre	Monthly average number of calls (1000)	Number of communes		With transposition	Number of population of the attraction area (1000)
		with the absolute majority od calls	with the relative majority of calls		
Szarvas	6,6	2	3	—	19,0
Csongrád	5,0	1	3	—	10,5
Békés	4,5	2	2	—	7,4
Gyoma	4,0	1	1	1	12,4
Sarkad	3,9	1	8	—	16,4
Bácsalmás	3,7	—	7	—	15,4
Szeghalom	3,0	—	6	1	30,1

2. *Partial centres*

Communes are bound to several partial centres on some areas of the Southern Great Plain, where no central settlement has developed so far to be able to perform the central functions on an area as large as a district. In the districts of Dunavecse and Mezőkovácsháza there exist 3 partial centres each. (Table 4.). To these districts no commune is bound with the absolute majority of calls, communes with the relative majority of calls are few, and their attraction areas are small. Among them Mezőkovácsháza can be considered a transition between the attraction centres and the partial centres. The connections of the partial centres are mutual and intense.

Table 4.

Data of the partial centres

Partial centre	Monthly average number of calls (1000)	Number of communes with the absolute majority of calls	Number of communes with the relative majority of calls	Number of communes with transposition	Number of population of the attraction area (1000)
Dunavecse	3,8	—	2	—	5,5
Mezőkovácsháza	3,5	—	8	—	24,7
Medgyesegyháza	2,9	—	5	—	10,3
Kunszentmiklós	2,8	—	3	—	5,2
Solt	2,6	—	3	1	8,1
Battonya	1,7	—	3	—	4,6

3. *Sub-centres*

Sub-centre has been established on the attraction areas of the centres of high-order, where the attraction of the centre is weaker because of the distance or other facts. On the other hand, sub-centres developed on areas where the attraction of the centre is high in absolute value but some communes are bound to another settlement with the most calls after the centre of the attraction area (secondarily).

We have regarded as sub-centres those settlements, to which one commune is bound at least with the relative majority of long-distance calls, or two ones with the most calls after the attraction centre (secondarily). On this basis, 24 sub-centres can be delimited on the Southern Great Plain. (Table 5.) Among them Kiskunmajsa and Jánoshalma approximate the level of the partial centres, they overlap the attraction of the centre within the attraction area of Kiskunfélegyháza or Kiskunhalas, resp. Kistelek is not able to do this over against the attraction of Szeged; owing to its large secondary attraction area, it belongs to the most developed sub-centres. There are 5 sub-centres in the attraction area of Szeged, 3 at Baja, 2 at Kecskemét, Kalocsa, Kiskőrös and Kiskunhalas each, 1 at Makó, Orosháza, Békéscsaba, Szarvas, Szeghalom, Gyoma, Kiskunfélegyháza and Solt each. The sub-centres such as Szőreg, Mórahalom, Csanádpalota, that developed on the attraction areas of the centres have particular activities.

4. *Interaction of the centres*

On Table 1. — by reason of the percentage of the initiated calls — we have also indicated the interaction of the centres. From the discrepancy of the intercalls of two centres in proportion to all the initiated calls, we can draw conclusions concerning the subordination and hierarchy of the centres.

Szeged occupies the top of the hierarchy of the Southern Great Plain. From among the three first-order centres it attracts Békéscsaba and it

Table 5.

Data of the sub-centres

Sub-centre	Monthly average number of calls (1000)	Number of communes with the relative majority of calls	secondarily	Number of population of the attraction area (1000)
Jánoshalma	3,5	2	—	4,2
Kiskunmajsa	3,3	2	2	10,5
Mezőberény	2,8	—	2	4,4
Kistelek	2,5	—	7	18,9
Tótkomlós	2,4	1	1	3,7
Szőreg	2,4	—	4	7,3
Dunapataj	2,4	—	2	2,2
Izsák	2,1	—	3	7,6
Soltvadkert	1,9	1	1	4,9
Sükösd	1,8	—	2	5,0
Kecel	1,6	1	1	5,5
Dévaványa	1,4	1	—	2,0
Vésztő	1,4	1	—	1,1
Tompa	1,3	—	2	6,9
Kondoros	1,3	—	2	5,6
Harta	1,2	1	—	0,8
Bácsbokod	1,2	—	3	6,5
Lakitelek	1,1	—	2	5,6
Üllés	1,1	—	2	4,5
Vaskút	1,0	—	2	5,5
Csanádpalota	0,9	1	2	2,4
Mórahalom	0,9	—	4	16,3
Miske	0,7	—	2	3,1
Pusztamérges	0,5	—	2	4,7

exercises a considerable attraction on Kiskunfélegyháza and Kiskunhalas, which are bound to Békéscsaba, or Kecskemét, resp. (6—9% of the calls). Within Csongrád County it is Hódmezővásárhely, that is strongly attracted by Szeged (41.0% being a considerable value in urban relations, as the towns exceed the communes in the diversification of Calls), however, the relative numbers of Makó (29,7%), Szentes (22,7%), and Csongrád (17,5%), are high as well. In spite of this, Csongrád is already attracted by Szentes for the most part (40,4%). Makó and Csongrád are attracted also by Hódmezővásárhely, while the interaction of Szentes and Hódmezővásárhely is equable, practically. It deserves attention that 4,1% of the calls of Hódmezővásárhely is directed towards Orosháza.

In Békés County, a more complicated system of interaction has developed. The most part of the centres is attracted by Békéscsaba, but a high proportion is seen only in the case of Békés and Gyula (34,5%). Orosháza, Gyoma and Szeghalom are attracted by the county seat with about 18%, but Szarvas only with 14% of the calls. Sarkad and Gyula show a stronger interaction than Sarkad and Békéscsaba (21,7 resp. 15,5%). Gyoma is attracted by Szarvas, and Szarvas—Orosháza. The interaction of Gyula and Békés is equable and comparatively loose. It is remarkable, that 17,0% of the calls of the county seat is directed towards Gyula. It is the highest proportion of attraction in the case of the first-order centres, — not mentioned the calls of Budapest — and it has come into being in consequence of the functional division of labour between Békéscsaba and Gyula. The interaction of the partial centres of Southern Békés are interesting. Battonya is attracted by Mezőkovácsháza, and the latter — even if with some difference — by Medgyesegyháza, which deserves attention, as Mezőkovácsháza is the seat of the district. Their relations to the high-order centres from the South to the central part of the county are the following: Battonya is bound to Orosháza as against Békéscsaba, Mezőkovácsháza is much rather, and Medgyesegyháza is bound decisively to Békéscsaba, though their relations to Orosháza have remained.

In Bács-Kiskun county, the most part of the centres is bound to Kecskemét. Apart from the high proportion of Kiskunfélegyháza, which is in close connection with the county seat, the proportion of calls directed to Kecskemét is between 7.3 and 16,8%. Bácsalmás is bound to Baja, with a proportion of 32,9%. Baja exercises strong attraction on Kalocsa, and as against Kecskemét, it attracts Jánoshalma, one of the most developed sub-centres as well. The most calls of Kecskemét are directed to Baja beside Budapest and Kiskunfélegyháza.

Apart from the attraction of the county seat, Kiskőrös is attracted by Kiskunhalas, and Kalocsa, Kiskunhalas and Kiskunfélegyháza are also attracted by Szeged. There is an interaction among Dunavecse and the other two partiaé centres, which can be considered equable. Kunszentmiklós and Dunavecse are attracted Kecskemét and Solt by Kalocsa.

IV. Evaluation of the method

It is clear, — on the basis of the comparison with the results of the studies, mentioned in the introduction, — that by the help of the applied method, it has managed to delimit the attraction areas of the individual centres, on the same or similar way as earlier. It concerns not only the direct attraction area, marked on the map too, but the attraction area overlapped by other centres. The order and hierarchy of the individual centres can be stated in accordance with other investigations. Accordingly, all the attraction factors, other-wise divergent in character and regional impact, come to a common denominator in the number and distribution of long-distance calls. Beside its simplicity this complex character is the greatest advantage of the method.

Naturally, — as we have mentioned in the introduction — this method does not replace other methods used in the research of attraction centre and area, it can be utilized only together with them. In consequence of its complex character, this method hides different regional attraction of the investigated functions, although their clear differentiation is often necessary. However, the delimitation of the synthetical attraction area encounters certain difficulties, since the attraction of some functions of great importance scarcely appears in the calls, so their regional influences are not in accordance with their significance. In consequence of the low telephone-density, the direct attraction areas, delimited by the utilized method „insist on" better to the district-boundaries, than the areas outlined by other methods.

At our concrete survey — chiefly at the delimitation of the overlapped attraction areas, — it was also a limiting factor, that at each commune only the data of the five centres called most, have been available. If we used the data of a given year broken down according to months, instead of the monthly average, we could draw a more dynamic picture, which would be able to express the seasonal changes of the regional relations as well.

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CLIMATIC AND EDAPHIC DEMANDS OF GROUNDNUT GROWING IN HUNGARY

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Introduction

Groundnut is an important nutrient and oil plant of the tropical and subtropical zones. Its seed and oil — on account of the wide possibilities of their utilization — are products in demand in the areas of the temperate zone as well.

Brasil is its ancient home, though its South-American origin was not accepted by all research workers (e. g. R. Brown), it is undoubtable however that the Spanish Oviedo mentions it already in 1547 as plant very frequent in the gardens of Indian (REINHARDT, 1911).

The plant was described in 1579 by a Spanish physician Monardes, then in 1753 in details by Linné (SPRECHER VON BERNEGG, 1929).

Investigations of the French botanist, A. De Candolle confirmed likewise the Brazilian origin and this opinion referring to the origin of the plant is also accepted nowadays.

According to some opinions it reached Africa in the 16-th century already, while F. H. BAHTEEV (1960) estimates that it spread in the 18-th century to Africa. Its distribution in Africa and North America is in connection with the slave trade between the Continents.

In Europe knowledges of the plant were obtained already in the 16-th century, it arrives however to the European Continent only in the 19th century through Spain. Its growing was attempted in Europe mainly on the southern areas (in Spain, France, Italy, in Bulgaria and on the southern territories of the Soviet-Union and such efforts are continued even today with more or less success. In our days it is grown from the 43° of N-latitude to the 38° of S-latitude.

The plant has two types:

with a procumbent stem (Arachis hypogaea var. procumbens) and the second with an erect stem or bushy (Arachis hypogaea var. fastigiata.)

The vegetative period of the procumbent type lasts 160 to 180 days, the most frequents being Virginia Runner, Jumbo and Virginia Bunch (this latter is of the semi-erect type). The vegetative time of the erect type is shorter, 120 to 150 days; the most important varieties are the White Spanish, Red improved Spanish, Valencia and Red Tenessee.

India is the most considerable groundnut producer of the world, nevertheless it is in African countries the most wide-spread. According to B. BADINAND (1967) the world production was distributed in 1966/67 as stated below (Fig. 1.)

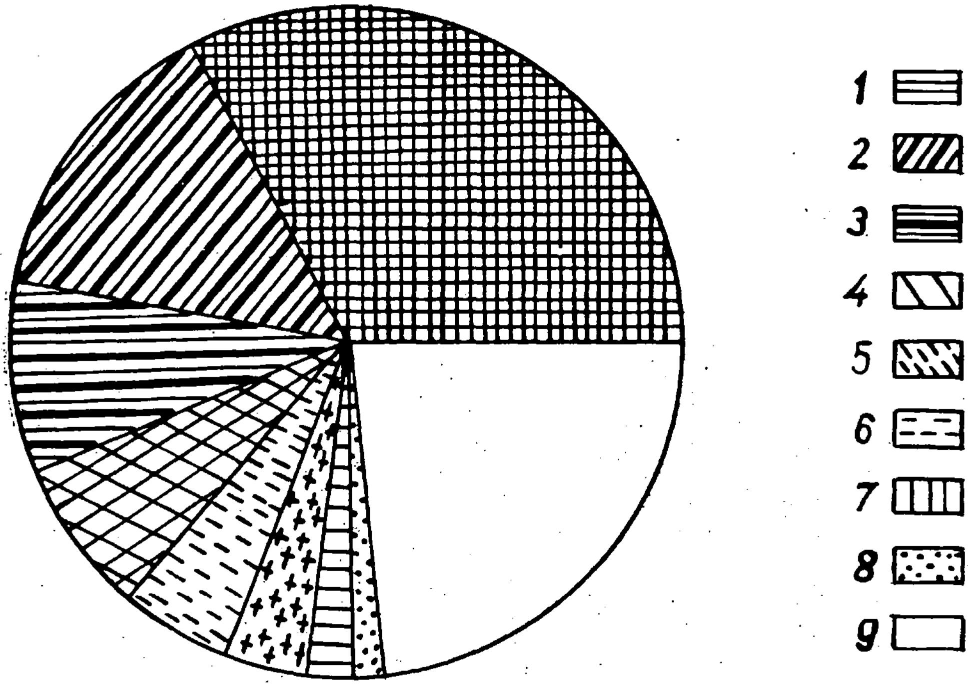

Fig. 1. Distribution of the world production of groundnut in 1966—67. 1 = India, 2 = China, 3 = Nigeria, 4 = United States of America, 5 = Senegal, 6 = Brasil, 7 = South Africa, 8 = Argentine, 9 = Others.

The product entered into the World Trade in the beginning of the 20-th Century. Senegal and Gambia were the first exporters. The groundnut with a raw seed-coat and the groundnut-oil participate also today with a significant share in the world exports of agricultural products (Fig. 2.) 1965.

The groundnut requirements of Hungary were imported in 30 per cent in 1962, but in 1967 already 87 per cent were covered from imports. The reduction of the domestic productive areas and of crop-averages is responsible for the increase of imports. In these latter years our import was in function of the inland production and of the favourable trend in the world market prices (Fig. 3.)

In the months of September and December the groundnut prices are high on a world scale. In 1967 the price of groundnuts was regulated and it amounted to 180 $/ton on the world market. This low price remained in vigour between the years 1967—1969 (B. BADINAND, 1967).

As the groundnut is a seasonally (chiefly in winter) demanded commodity also in Hungary (in roasted condition it is claimed by the retailed trade), thus the requirement in this direction could be satisfied with a small-size increase of the actual crop-land and with the quantitative and qualitative improvement of the production. A problem is caused however by the supply of the oil-industry with groundnut-oil.

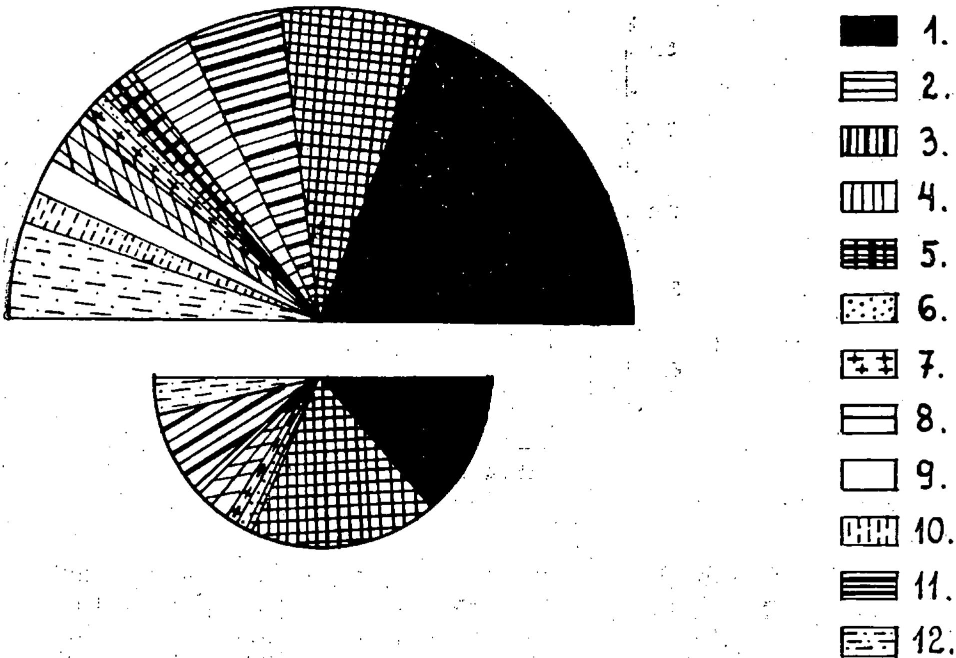

Fig. 2. World-exports of the raw seed-coated groundnut and groundnut oil in 1965. I. Raw seed-coated groundnut. II. Groundnut oil. 1 = Nigeria, 2 = Senegal, 3 = Sudan, 4 = Niger. 5 = Mali, 6 = Republic of South Africa, 7 = Portuguese Afrika, 8 = United States of America, 9 = China, 10 = Brasil, 11 = Others, 12 = Argentine.

The present study aims et the examination of the most important conditions of groundnut growing — of its climatic and soil demand — in the interest of the above outlined yield-increase.

Seeds of the plant contain 14 to 16 per cent carbohydrates, 23 to 37 percent proteins, 14 to 56 percent oil and 8 percent water. Their calory-value is high. After the first cold pressing of the seeds the plant yields a for eating outstandingly suitable oil, of a value similar to that of the olive-oil, which is consumed mostly in the form of table-oil but can be well utilized also in the canning-, sweets and pharmaceutical industries. Its seed is after roasting a very much liked dessert in our country as well. The residual product of pressing, the oil-cake, is utilized likewise in several ways by the sweets industry and baker industry; may come into consideration as an excellent feed also in the cattle-and pig-breeding. Hay of the groundnut is a green manure equivalent to clover and lucerne. The shelled pod is suitable for insulations.

In Hungary the retail trade and the sweets industry lay a claim for roasted groundnut. The groundnut oil is employed by the vegetable oil industry for margarine manufacturing. For the latter purpose a quantity of 1000 to 1500 tons raw material would be required to the economical utilization and this quantity cannot be warranted with the actual volume

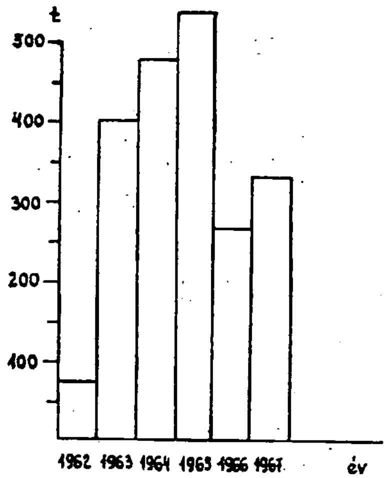

Fig. 3. Trend in the groundnut-imports of Hungary in the last years.

of production since in the last years the necessary quantity was produced in Hungary only in 1964. Taking however the demand of the retail trade and sweets industry into consideration, the oil-industry will be compelled also in the future to have to recourse to the importation of groundnut or groundnut-oil respectively.

The groundnut reached Hungary in the beginning of the 1900 years. It was about 1935, when on the Plant Production Experiment Station at Szeged a commencement was made with its acclimatization (RIGLER, 1937). Later on, experiments with its growing were conducted sporadically even in several counties. In 1936 already 87 producers were kept in evidence in the country. Acclimatization of the plant acquires a particular importance at the time of the import-prohibition in 1936. Early in the 50-ies a serious attention is devoted again to the growing of groundnuts. In 1951 it is included in the modified Five-Year-Plan among the plants to be acclimatized. During the research of productive regions 45 groundnut-sites have been examined (BRUDER, 1952). Mezőhegyes, Sövényháza and Tótkomlós were the habitats giving the best yields. The production was then extended also to other communities of the Mezőkovácsháza district. In 1954 several producers of the district have attained crop averages between 8 to 10 q/cad. hold (KARAKASEVICH, 1957). In 1960 groundnut was grown in Medgyesegyháza on areas of the Aranykalász and Béke cooperative farms on 550 cad. holds, in Ujkigyós om 320, in Medgyesbodzás on 100 and in two cooperative farms of Pusztaottlaka on 200 cad. holds (1 cad. hold = 0,57 ha.) Furthermore groundnut growing was pursued in the same year on the area of county Békés in further 25 communities, on areas under 100 cad. hold per community.

In Hungary the most important natural conditions of groundnut growing are:

a) climatic endowments,

b) soil endowments,

and its economic conditions:

a) soil cultivation,

b) return of the elements of soil fertility,

c) a high level of the mechanization of growing,

d) labour conditions,

e) import-possibilities.

These have acted in the direction that in our days the growing became confined to the boundary of Medgyesegyháza. The following table shows the reduction of the large-scale crop-land in the last eight years:

Size of the groundnut area in the cooperative farms of Medgyesegyháza (in cad. holds.)

1961	1962	1963	1964	1965	1966	1967	1968	1969
260	300	300	300	306	214	91	78	25

In 1968 in addition to the collective farms, growing continued also on 128 cad. hold household area.

In Medgyesegyháza the y/13 early ripening regional variety of Mezőhegyes, selected from the Valencia type of short vegetative period is wide-spread. (By crossing the Sovietic Stepnjak and the y/13 of Mezőhegyes a type with more advantageous varietal qualities sould be produced.).

In our opinion it would result useful to examine the given climatic and edaphic conditions among the conditions of groundnut growing, since this plant belongs to our plants to be acclimatized. Results of such an investigation may provide a direction indication for a reduction or perhaps extension of the production.

Climatic claims

The groundnut being a plant of the tropical zone — is susceptible chiefly to the temperature, length of the sunshine period, intensity of radiation as well as to the quantity of precipitations in the critical periods of its development. The trend in the crop-averages is thus considerably influenced by the trend in the mentioned climatic elements.

Due to a certain acclimatization the plant has spread on several areas of the temperate zone and thus also in our country. Its seed germinates above 12 °C, the development stops below 12 °C. Is sown mostly at 14 to 15 °C. A cold rain, a few days after the sowing, may be very harmful. Its sprouting supports already even — 1,5 °C, the more considerable fluctuation of the temperature acts however unfavourably on its development, at 0,5 °C the vegetative part of the plant is frozen off, while at —3 C the vital functions of the unripe pods cease (MINKEVICS—BORKOVSKIJ, 1951).

Seeds sown in the first decade of May (1—10th May) germinate after 10 to 15 days. The seed sown earlier than this does not lead to an earlier ripening in the majority of cases, since the time of sprouting may be considerably delayed. The extreme values of sowing date are 15th

April and 25-th May. The flowering starts earlier on plants sown at the proper time.

During the germination period — jointly with a temperature above 12 °C — the moisture content of soil is likewise important.

The warm soil is similarly a condition of the good germination ratio. The sown seed germinates in general between 15th and 20th May (Extreme values of sprouting: 10th May and lst June respectively).

Tillering begins at 18 °C daily mean temperature, the optimum temperature claim at this time is however 25 to 28 C. The tillering is enhanced by a favourable relative humidity of the air.

Flowering commences intensely in 30 to 35 days from sowing (from 10-th and 20-th June to 10-th and 20-th July). In case of a warmer weather flowering bushes may be found also earlier and at the same time in the autumn even about the 10th September. The periods of flowering and fruit-setting are critical (in the latter case precipitations are important from the point of view of soil moisture). During the vegatative period 250 to 300 mm precipitations are required, but from the point of view of yields in the phase prior to ripening (from May to August) 500 mm is the optimum quantity of precipitations. The most precipitations are required in June or in the first decade of July respectively at the time of flowering; due to the keeping the soil in moist condition however precipitations are important in July and early in August as well. When the necessary quantity of precipitations is not obtained during this period, irrigation is required. According to experimental data (KOVÁCS, 1960) the irrigation performed in due time contributes to the shortening of the vegetative period and to the increase of the crop-averages also in our country.

Groundnut ripens in the fifth month after sowing. At the time of ripening, in the second half of September and early in October — but already commencing from 10th or 20th August respectively a sunshine-period is demanded, excessive precipitations lead to the deterioration of seeds. The harvesting time lasts from 20th September 20 20-th October.

According to Sprecher the groundnut thrives well, where the heat-sum of the vegetative period is 3600 °C. As demonstrated by Hungarian experiments it prospers also when the heat-sum is 2500 to 2800 °C (BRUDER, 1952). To ensure this heat-sum 65 or more summer days are required.

Nevertheless from the point of view of oil-accumulation — as already mentioned previously — the length of sunshineperiod is important and in the vegetative period 1200 to 1300 sunshine hours are needed.

In Hungary the above outlined climatic conditions are warranted mainly on the South-Lowland area. In the following let us examine the given climatic conditions of Medgyesegyháza and of its environs on the basis of a 50 years average. (The temperature data are values interpolated from the data of the climate stations at Békéscsaba, Orosháza and Mezőhegyes of the National Meteorological Institute. The precipitation data originate from observations of the Farm at Bánkut.)

The vegetative period of groundnuts in Hungary lasts from May to October. On the ground of 50 years average, during the vegetetive period the mean value of temperature does not fall below 10 °C in none of the months (the lowest October temperature was 11,1 °C), while in May 16,7 °C is the mean temperature. The annual sum of the sunshine period amounts to 1991 hours of which 1419 hours fall to the vegetative period. On the area the heat-sum of the vegetative period is 3293 °C, and quantity of precipitations 327 mm, both on the ground of 50 years average. With the highest probability (14—14 percent) the 251—275 mm and 326—350 mm precipitation quantities occurred during the vegetative period. The annual average number of summer days is 86,3, that of heat days was 26,8. In June (at tillering time) the mean monthly value of the relative air-humidity on the climate stations of Békéscsaba and Mezőhegyes are 65 and 66 per cent respectively (National Meteorological Institute: Atlas of the Hungarian Climate, Volume II. Data-Collection 1967).

Mean value of soil-temperature (50 years average) in 10 cm depth at Mezőhegyes is 12,4 °C, already in May 17,4 °C and 12,6 °C in October, in 5 cm depth 12,6 °C, in May 18,1 °C, in October 12,7 °C. The temperature demands of groundnuts are therefore satisfied in this respect as well.

In the following we are performing — on the ground of the last 7—8 years — the comparative examination of the climatic data (temperature, heat-sum, length of the sunshine period, precipitations) important from the point of view of plant developeent and of the crop-averages (Fig. 4.)

Comparison of the climate-data of the period between 1960—67 with crop-averages

The plant being in the course of acclimatization also at present is the most sensitive to the air-temperature and soil-temperature at the time of sprouting (first decade of May), to the precipitations at the time of flowering and fruit-setting (June, July) and to the heat-sums and length of the sunshine period from flowering to ripening (August—September).

In conformity with the minimum law the plant is particularly susceptible in its critical periods to those or that factor which are present in minimum. In the following we are examining the correlation of crop-averages and critical factors for the above-mentioned years. We do not digress to the detailed analysis of the given climatic conditions existing in optimum.

In 1960 the crop-average (it was 5,5 q/cad. hold) exceeded that of 8 years (4,8 q) cad. hold and cannot be ranged among the well-yielding years. The soil temperature in the germination period is, related to 8 years, of a very low value. The precipitations fallen during the vegetative period would have been quantitatively sufficient but the ripening ratio was spoiled by the precipitations having fallen in September—October for the greater part. The length of the sunshine-period and the heat-sum during the vegetative period have also lagged far behind the best year (1963).

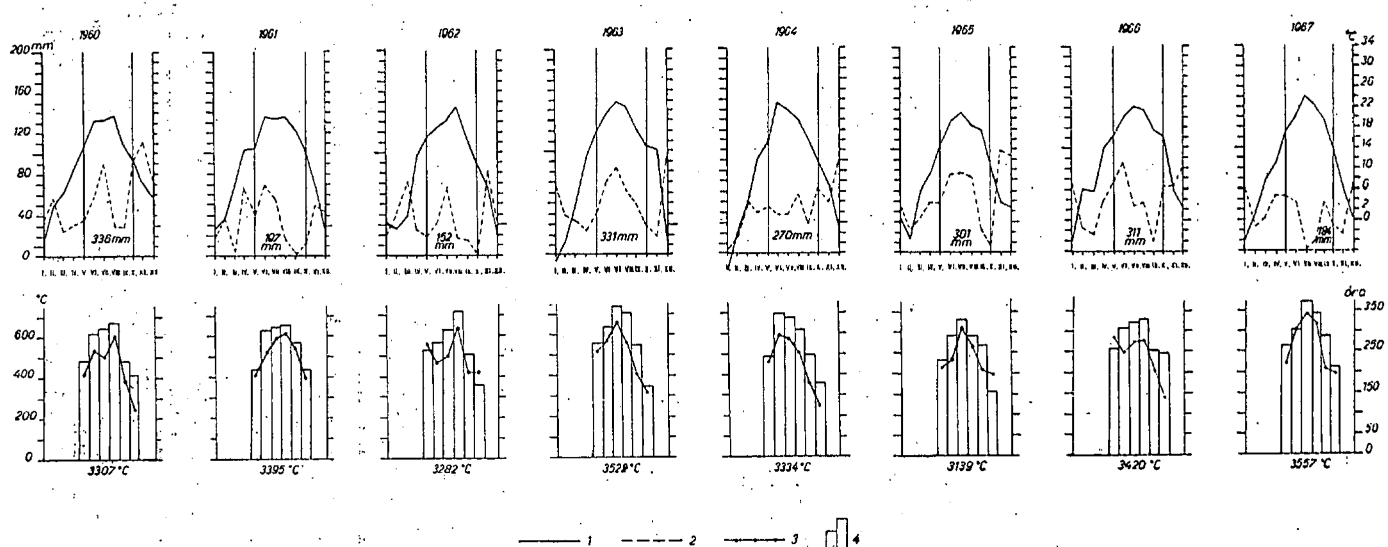

Fig. 4. Climatic data of Medgyesegyháza in the examined period: 1 = monthly mean temperature, 2 = precipitations, 3 = length of sunshine period, 4 = heatsum.

In 1961 the precipitations at the time of germination and fruit-setting amounted to 50—70 mm and also the total quantity of precipitations during the vegative period was low.

In 1962 again the precipitations were few and even at the time of flowering and fruit-setting did not reach 70 mm July precipitations caused a considerable reduction in the soil temperature.

The best year of our examined period was 1963 with 7 q/cad. hold crop-average. Therefore a detailed analysis of the total vegetative period seems opportune. With the exception of August the air temperatur was in all months of the vegetative period superior to the monthly means of former years, which is shown also by the 3522 °C heat-sum of the vegetative period. The trend in time of the temperature was similarly adequate. At germination time the air temperature exceeded 17 °C, while in July was above 23 °C. Abundant precipitations fell at the time of flowering and fruit-setting (June—July). Prior to the ripening period two-thirds of the precipitations of the vegetative time reached the soil. A strong warming-up of the soil and surface could be observed. Already at sowing date the mean temperature was between 18—20 °C, while in July it went above 24 °C in all the three soil-horizons (OMI, 1963).

In 1964 the crop-average decreased to 5,2 q/cad. hold The reason for this may be sought in the strong fall of air- and soil temperatures commencing from July, against which the quantity of precipitations rose in August (at the time of ripening). This latter fact led to a substantial cooling down of the soil and hereby to the lengthening of the ripening process.

In August 1965 a considerable heat-decrese occurred similarly to that of July in the preceding year and though the plant obtained the precipitations also in the critical period, the August-precipitations have reduced the ripening percentage. The heat-sum of the vegetative period was similarly the lowest (3139 °C) in this year.

In 1966 the distribution of precipitations in time was not appropriate: little precipitations fell in the period of fruit-setting and the not too high (20—22 °C) temperature in July and August contributed unfavourably to it. The regression in the sunshine-period of June or the low hour-values in July—August respectively play a substantial role in the formation of the poor crop-average.

In 1967 the crop-average is again above the 8 years' average. In this year precipitation is a factor existing in minimum (184 mm). Precisely in the critical period of fruit-setting the plant did not receive the desired quantity of precipitations. The other weather factors were given in optimum, thus in this year the irrigation would have resulted in a higher crop-average.

It can be established that in the examined 8 years period the shortage of precipitations and the intensive change of soil temperature were responsible for the low crop average.

We can consider that with the concrete analysis of weather factors made in the above-said, the connection between the weather and crop-averages is fully proved.

Our findings are confirmed also by the correlation coefficients computed on the basis of the simple bivariate correlational connection. The variables were formed by the individual weather factors and the crop averages (relatively to the years 1960—67.).

The correlational coefficient is expressed by the connection:

$$v = \frac{\sum x_i y_i}{\sqrt{\sum x_i^2 y_i^2}}$$

As a matter of fact we have used here the first step of the „critical factors" method (DR. LÁSZLÓ HALABUK—KATALIN HULYÁK, 1961) of the mathematical statistics for the demonstration, as this part serves for the justification of the traditional factors.

On our area (Medgyesegyháza, Haladás cooperative farm) the sum of the sunshine period during the vegetative time and the heat-sums of August show a positive correlation with the crop averages (correlational coefficients: 0,6719, and 0,7152 respectively), the quantity of precipitations however resulted in a negative correlation precisely in the critical period (June). The precipitation-quantity increasing in September led likewise to the decrease of the crop averages. On the ground of the regression hyperplane equation ($x_1 = a_1\, b_{12} x_2 + \ldots + b \quad x \quad$) the multiple correlation of the crop average as of a dependent variable and of the critical factors as of independent variables can be examined further on (the latter is however not a task of this study).

The mathematical method — jointly with working-up the empirical material — supplied data for the examination of critical factors of the groundnut in the above, according to which in the examined 8 years the crop-averages of groundnut were influenced by the following weather factors on the area of Medgyesegyháza:

a) the mean-temperature of air in positive,

b) the heat-sums and the sunshine period in positive, and

c) the measured quantity of precipitations in negative direction.

Since on the basis of an 8 years average the measured quantity of precipitations proved small among the weather factors, it is desirable to analyze the trend in this latter factor on the basis of a longer period. (Precipitation data are also further on data of Bánkút—Rózsamajor climate station).

As already earlier set forth by me, 250 to 300 mm precipitations in the vegetative period are sufficient for groundnut growing under our native conditions. Apparently this condition is similarly given on the area, since on the ground of 38 years data (between 1931—1968) the average of the precipitation amount in the vegetative period was 320,9 mm. During this time with 47 per cent probability could be counted upon this precipitation quantity, which means that a year in which 300 to 400 mm precipitation was measured, occurred every two years. Being aware of the developmental phases of the plant we know also that the plant demands a considerable percentage (at least 70 per cent) of precipitations during the vegetative period at the time of flowering and fruit-setting, thus the former examination of the precipitations of the vegetative period cannot serve as a departing point for our expositions. It is more advisable to examine the precipitation conditions of the flowering and in part of the fruit-setting period (10th June to 20th July). The analysis seems to be justified as according to Florov (KOVÁCS, 1960) the precipitation conditions are of the optimum when prior to ripening 500 mm precipitation arrives on the soil.

Between 1934 and 1968 the precipitation average of 35 years was 84,5 mm in the mentioned period. This gives barely more than 30 percent of the total precipitation quantity of the vegetative period. Frequency of 100 to 150 mm precipitations is 3,5 years, while in 11,6 years once can be counted upon precipitations above 150 mm. These latter figures provide an evidence that the growing becomes uncertain without irrigation.

The quantity of early autumn precipitations (month of September and early October) has — according to the examination — a minor influence on the crop results, since on 33 years' average a quantity of precipitations — from 1st September to 20th October — was 61,5 mm. In some years (1960, 1968) however the autumn precipitation conditions have likewise contributed to the reduction of the ripening ratio.

The detailed analysis of precipitation amounts on the average of many years shows that this condition is not warranted in the critical periods of the plant and the growing may perhaps become reliable and safe with irrigation.

Edaphic claims of groundnut growing

The well aerated, light coloured soil, rich in nutrients is the most convenient for the growing of groundnut. On tropical and subtropical areas it is grown in laterite and terra rossa, in the temperate zone on sand- or sandy soil. The nitrogen-fixing bacteria do not survive on sticky, loamy soils and the danger of seed-rotting subsists in the period of seeding and ripening. The optimum soil for the plant is a pH value between 6,0—6,2. On more acidic soil liming is to be applied to neutralise the soil acidity.

In Hungary groundnut is grown in the Mezőkovácsháza district on sandy soils.

The crop-land extends on the southern loess-ridge beyond the River Tisza. In the Pleistocene during the sedimentation in the Maros River gravel, sand, silt and on the top, loam became deposited on the surface. Sedimentation was modified by tectonic movements as well as by changes of the climate, thus on some places the sediment layer is repeated. Later on from the flood plain a drift sand surface became established from the sand blown out by the wind, on which by the end of the Pleistocene a subtle alluvial material became deposited in the form of a dropping dust. The loess is the mixture of the typical and infusion-loess. A large part of the area is covered by the former and of a Lowland-loess developed in the Holocene in a similar way. (STEFANOVITS, 1963). Depending upon the mechanical composition of the loess, various soil-types came into being. On silty loess tchernozjom and meadow tchernozjom, on sandy loess soils of chernozem character, on loamy Lowland-loess meadow and alkaline (szik) soils developed. The light, loose, sandy variant of the Lowland loess was formed on the higher terrains, while the loamier variant on the lower situated parts.

On the central part of the region, in NE—SW direction Lowland chernozem-soil with lime incrustation can be found. A considerable part of the area is dominated however by meadow-and in depth salty meadow chernozems. On lower situated parts meadow-soils and meadow soils turning into steppe are frequent.

The Pedological Department at Szeged of the National Agricultural Quality Testing Institute, under the direction of József IMRE conducted a soil survey in 1965 in the boundary of a community important also from the point of view of groundnut growing, on the area of the Aranykalász and Béke cooperative farms at Medgyesegyháza. Results of the examinations were summarized on the basis of local minutes on genetical soil-maps, humus-cartograms, nurient-cartograms and soil utilisation cartograms. On the ground of the four cartograms we have drawn up the additive soil-cartogram, of the cooperative farms which since then were amalgamated under the name Haladás (Progress). (Fig. 5.). The areas utilized in 1965 with groundnut growing were also indicated on the map (on basis of the Minutes).

On the area of the Cooperative Farm meadow chernozem, chernozem meadow, leached chernozem and calcareous — and chernozem with lime incrustation — soils respectively occur. For groundnut growing one subtype of the meadow chernozem, the carbonate meadow chernozem and also the calcareous and chernozem soils with lime-incrustation are suitable. We shall now proceed to the examination of these soil-types with an exhaustive analysis of a soil profile of each.

On medium-high terrains *meadow chernozem soils* can be found in the largest extension. They have a blackish or darkbrown colour, an angularly crumbly structure and on the more southern parts are stickier more strongly. Thickness of the humus-layer is 80 to 110 cm on the average, the total humus content is on the N—NE parts 1,5 to 2,5 but in some sites 3 to 4 per cent. In the humus layer Ca is the prevalent replaceable cation. The groundwater has an alcaline quality, its medium depth being 2,3 to 3,6 m and its level seasonally changing.

Among its sub-types the carbonate and in depth solonetz chernozem soils are very frequent.

In S—W. direction from the boundary of Pusztaottlaka community the clayey sand-soils, of blackish-brown colour, and of tiny crumbly structure, becoming dusty on pressure are dominant on the surface, in medium depth *carbonate meadow chernozem soils* having on the protuberant parts a deep and on medium-high terrains very deep humus layers. Groundnut is grown on this soil type on the largest area. The dominating fraction is an — in its mechanical composition — coarse and fine sand. Thickness of the humus-layer is 81 cm, the total humus content in the upper 20 cm layer 1,85 per cent. In the same depth the soil pH is

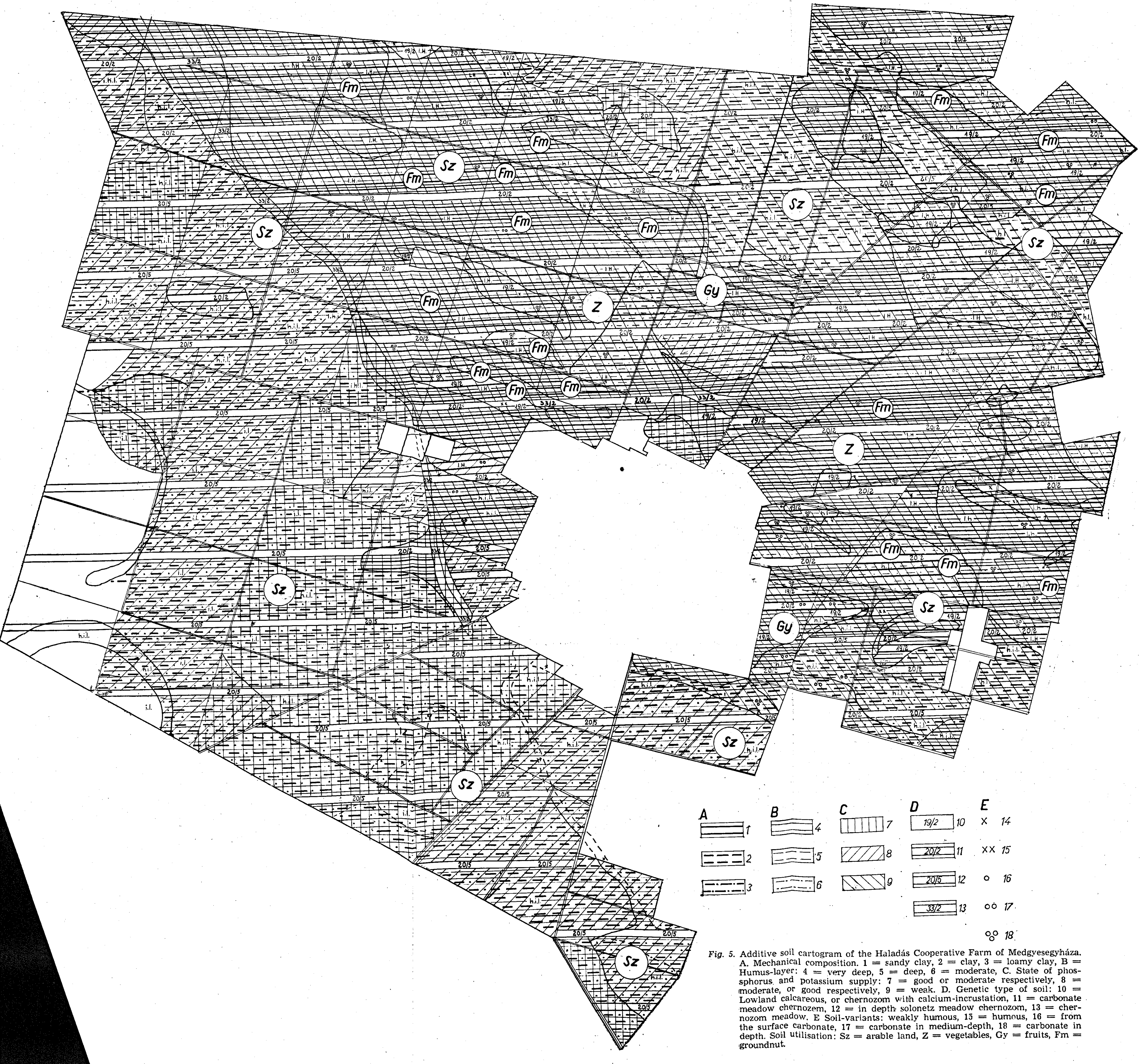

Fig. 5. Additive soil cartogram of the Haladás Cooperative Farm of Medgyesegyháza. A. Mechanical composition. 1 = sandy clay, 2 = clay, 3 = loamy clay, B = Humus-layer: 4 = very deep, 5 = deep, 6 = moderate, C. State of phosphorus and potassium supply: 7 = good or moderate respectively, 8 = moderate, or good respectively, 9 = weak. D. Genetic type of soil: 10 = Lowland calcareous, or chernozom with calcium-incrustation, 11 = carbonate meadow chernozem, 12 = in depth solonetz meadow chernozom, 13 = chernozom meadow. E Soil-variants: weakly humous, 15 = humous, 16 = from the surface carbonate, 17 = carbonate in medium-depth, 18 = carbonate in depth. Soil utilisation: Sz = arable land, Z = vegetables, Gy = fruits, Fm = groundnut.

7.3, its value increasing with the depth. Poorly supplied with phosphorus and potassium, but well and moderately in patches.

The adequate nitrogen supply of the soil is ensured by the groundnut (as it is a papilionaceous plant). On the lower parts of the 30 to 35 cm horizon calcium-incrustation and calcium-concretions can be demonstrated, the upper horizons are, however, poor in calcium. For this reason liming with 20 q/cad. hold dosage, mixed with organic manure, is suggested by József IMRE (on the ground of his investigations). Following the manuring, however, a copius rain or an excess irrigation respectively is detrimental as an elution of the nutrients and a deterioration of the soil structure may occur.

Calcareous and lime-incrustated chernozem soils are like-wise encountered (though on a smaller area on the N and E foreground of the community in patches.) In contrast to the leached chernozem here the calcium carbonate may be found already from 52 cm. The soil-pH is about neutral in the upper 20 cm, while in deeper layers the reaction is slightly alcaline. $CaCO_3$ is present in the form of calcium-veins and calcium-incrustation. The upper 50 cm are poor in calcium, therefore in plant growing the above mentioned liming is necessary also here. Its subtype occurring on the area is a calcareous Lowland-chernozem developed on loessy sand. It is a dark brown, in some places blackish brown coloured soil, with 1,6 to 2.7 per cent humus content and an average 80 to 100 cm thickness of the humus layer.

Replacement of the elements of soil fertility

Groundnut is pretentious toward the soil, so that a replacement of the nutritive elements is necessary by all means. The research workers are in agreement concerning the need of organic fertilization in view of maintaining the soil fertility. On soils of lower quality the application of 150 to 200 q barnyard-manure is recommended which is to be brought into the soil under the previous plant or by ploughing it down in the autumn. Among chemical fertilizers 100 to 150 kg potassium-salt are necessary per cad. hold. The potassiumsalt has to be dispersed one year but at least one month prior to seeding as it is taken up by the deeper benetrating roots. The potassium salt present in the upper soil layer hinders the absorption of calcium. In Medgyesegyháza 100 kg/cad. hold potassium salt were used in the last years (1965—1968). Phosphorus fertilization has to be employed on soils poor in phosphorus. The Hungarian crop-land is for the greater part moderately supplied, therefore the phosphorus quantity used per cad. hold in the last three years is increasing.

In addition to the state of humus- and nutrient supply of the area also soil-utilisation can be read off from the Chart. On this the sites of groundnut growing have been marked within the branches of cultivation.

In the knowledge of soil-characteristics the productive area could be extended to the carbonate meadow- and to the in patches occurring calcareous or calium-incrustation Lowland-chernozem soils which can be found in the eastern foreground of the community. On soils moderately supplied with phosphorus the cultivation shall be combined with phosphorus fertilization.

Sandy soils of similar properties can be encountered on other areas of the Mezőkovácsháza district as well (Fig. 6.), thus in the N-foreground of Pusztaottlaka, Almáskamarás and Kevermes, in the Westen foreground of Nagykamarás and of the Eastern of Kemeres, and also in the N-boundary of Medgyesegyháza. From the soil point of view this area is similarly suitable for groundnut growing. In its main features the area tallies with the terrains suggested for groundnut growing by Karakasevich (1960).

The above examined natural factors, given on the area, correspond to the claims of the plant only in part. Particularly the inappropriate distribution of precipitations may cause damages in the crops. The shortage of precipitations in the critical period and the abundance of precipitations in the autumn lead — on the ground of experiences gained in the production — to a deterioration of the quality. A certain soil-weariness appears likewise together with the given soil conditions which are already otherwise not al all in the optimum.

Quality of the seeding material has — in the opinion of local specialists — depreciated in the last years, in view of which fact they are engaged in the ara in producing good seeding material by way of selection.

In addition to the examined natural conditions — as we have already pointed out in the introduction — the development of groundnut growing in Hungary is influenced also by other factors, such as e. g. by the level at which the production is mechanized, labour situation, rentability conditions, import possibilities. To support the latter we are now examining the rentability of groundnut growing.

Rentability of the production

In Hungary groundnut is utilized in roasted condition as dessert and in raw state as basic material of the sweets industry and of margarine manufacturing. On the ground of experiences made so far in the large-scale production a quantity economical for the oil-industry cannot be safely produced.

Referring to groundnut growing a calculation was made by János Bruder in the beginning of 50-ies by which he wished to demonstrate the rentability of inland production. He has shown that with a 5 q per cad. hold crop-average the production cost of 1 q groundnut is 274 Ft. Among the inputs he did not take in consideration however the seeding material requirement, fertilization or the numerically even today not demonstrable accessory costs respectively. Besides these he could not be aware of many years experiences of a largescale production of which nowadays data are already available for us. The trend in crop-averages and production-inputs is the following in the Haladás Cooperative Farm of Medgyesegyháza:

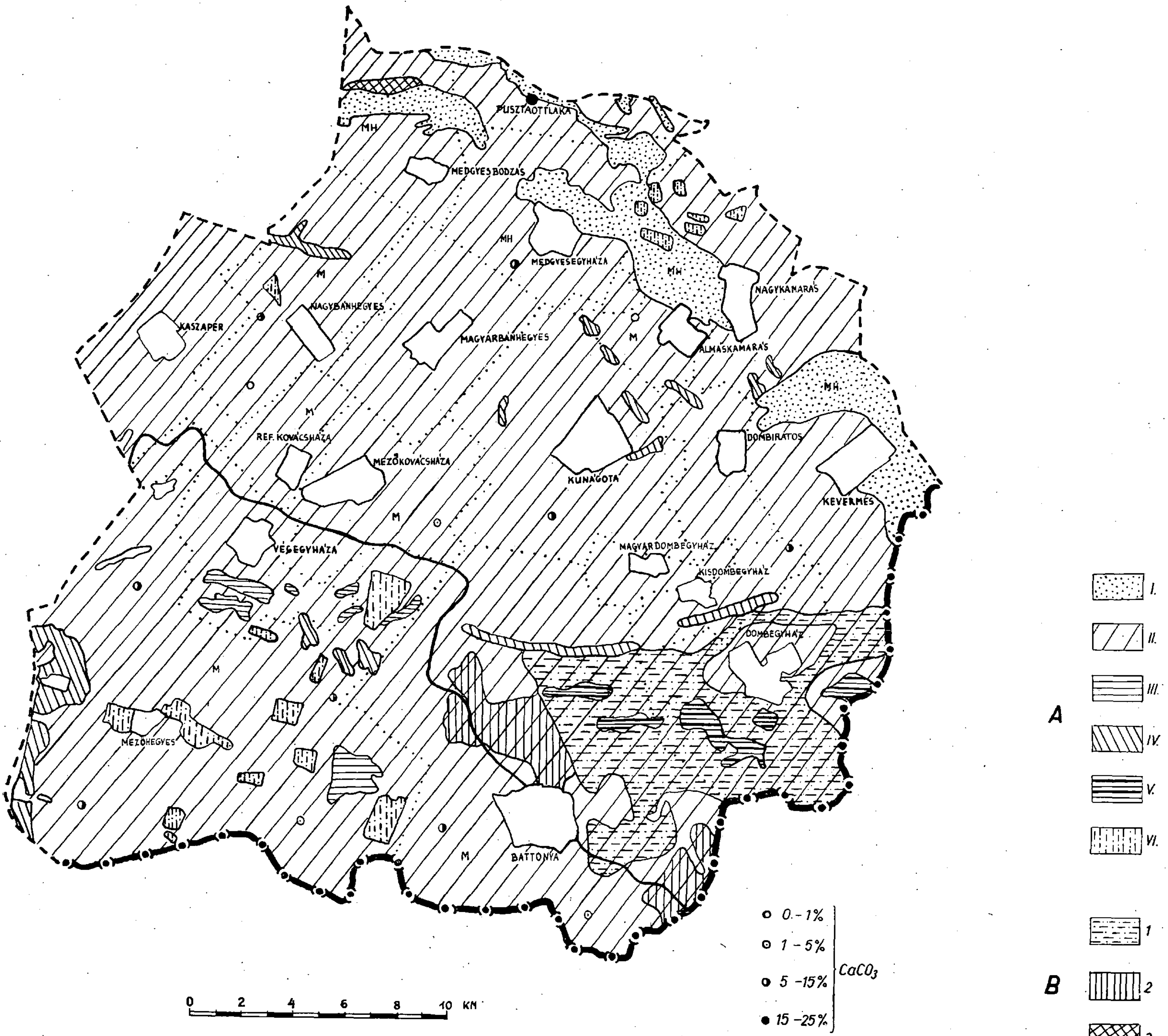

Fig. 6. Soil-chart of Mezőkovácsháza district (after Andó). A. I = sand, II = clay, III = loam, IV = conditionally productive meadow, V = infertile alkaline (szik), VI = forest, B. 1 = sodic, saline layer, 2 = sodic ameliorable with calcium carbonate, 3 = sodic (szik), ameliorable with gypsum or other material with acidifying effect.

	1960	1961	1962	1963	1964	1965	1966	1967	1968
Crop average q/cad. hold	5,5	5,0	4,8	7,0	5,2	3,0	2,6	5,3	2,5
Input q/Ft	758	834	868	595	802	1390	1604	786	1668

On the ground of several years' average we have calculated that 4171 Ft is the input for 1 cad. hold groundnut-growing (this includes the seeding material requirement, the cultivation inputs and chemical fertilization).

On this basis the production cost of 1 q groundnut with raw seed coat amounts to 1034 Ft on 9 years average in which the accessory costs are not comprised, e. g. control-operations in the case of pests, organic manuring and other inputs depending upon the extremities of weather.

While the Ft 274 input could be considered economical, with the latter amount the growing becomes uncertain particularly in years where crop-averages are weak (in 1966 the crop average was 2,6 q/cad. hold, in 1968 also 2,5 q/cad. hold).

Comparing the production cost of groundnut with the preduction cost of on the area grown other plants, we arrive similarly to the mentioned conclusion. In 1965 on the average of all the cooperative farms of the Country the production cost of winter wheat was 176 Ft/q, of barley 159 Ft/q (E. CSIZMADIA—L. DANKOVITS—L. UDVARI, 1968) while at the same time the production cost, on ground of a 9 years average, attained 1043 Ft/q. [This latter production cost was computed by means of the work unit Ft average of 7 years, the value of which is 37 Ft in Medgyesegyháza. From 1966 the income per capita of one working day reached on the average 90 Ft in the cooperative farms of the Mezőkovácsháza district and this contributed considerably to the increase of the groundnut production cost. Taking into consideration that groundnut requires an intensive cultivation (soil cultivation, hoeing, hilling up twice, pulling-up, hulling of the crop) — cultivation of 1 cad hold demands 18—20 work-days, this means a heavy engagement of manpower.] It is to be noted that the production cost demonstrated in the agriculture has not a quite veritable content and either the materialized labour figures at the effective price, the ratios may be however — even with a certain error percentage — direction-indicators.

The above mentioned plants, with their lower production cost, demand an extensive cultivation, the labour engagement is less heavy and beyond these — on the basis of the given natural-geographical conditions and of the production experience, produce safer and more reliable crops.

This tendency is confirmed by the change in the crop-structure of plant growing on the fields of Medgyesegyháza in the last seven years as well (Fig. 7.). The area sown to groundnut (within the other category) decreased and the areas sown to maize and roughages have also diminished. The area of sugarbeet is about unchanged while the areas sown to cereals and feed-grains increased.

On the basis of rentability (which we approached with the comparison of the raw production costs and buying-up prices, having considered also the 9 per cent rise of the buying-up prices in 1966) between

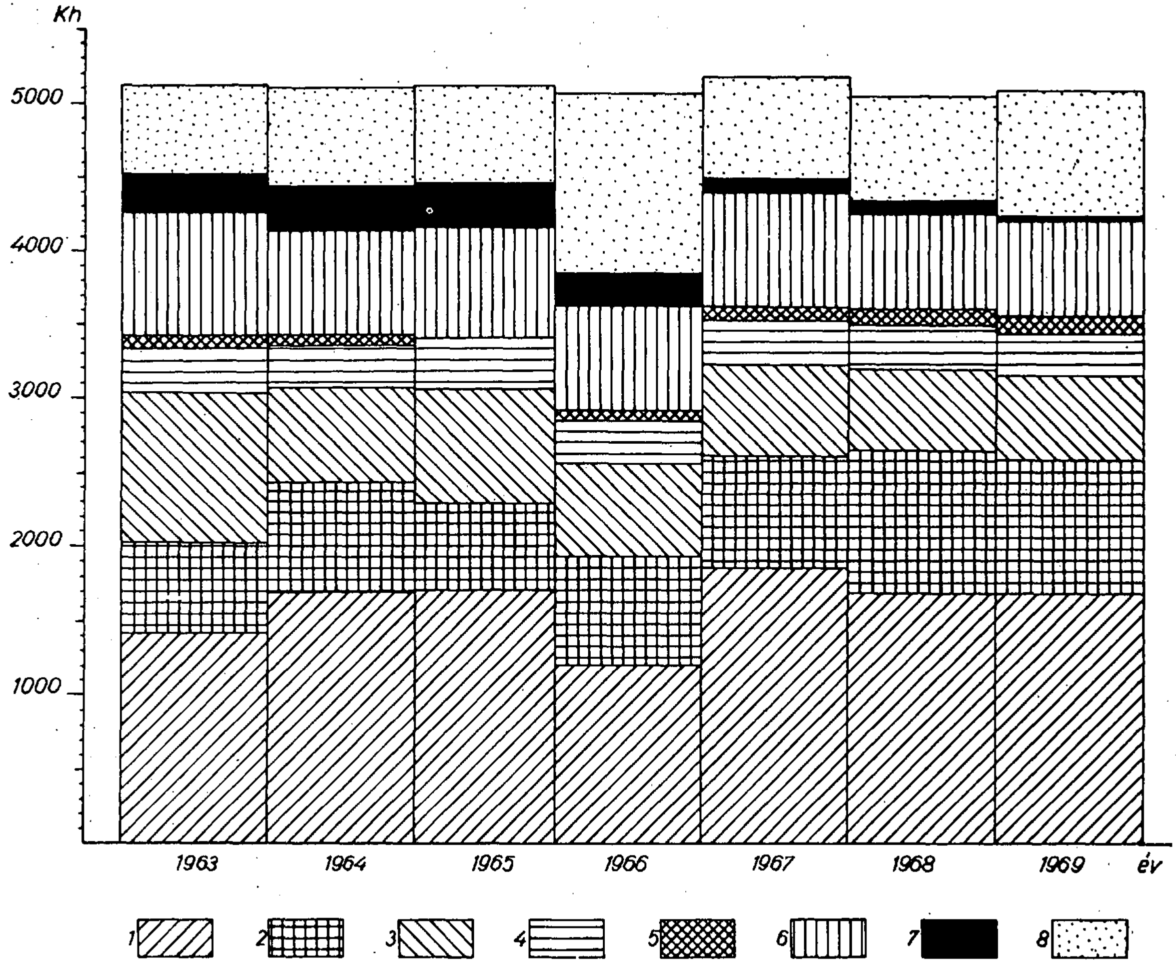

Fig. 7. Variation of the cultivation structure of cropping at Medgyesegyháza between 1963—1968.
1 = cereals, 2 = feed grain, 3 = maize, 4 = sugarbeet, 5 = potato, 6 = roughages
7 = groundnut, 8 = others.

1963 and 1967 an uniformly growing tendency is shown by the cereals (Fig. 8.). The income deriving from feed grain species is similarly increasing, though this increase cannot be called quite uniform. In the case of groundnut we may count upon a substantially larger income, in the individual years however the magnitude of the income is variable. Taking into account that the growing represents a substantial labour engagement and inputs and also the very considerable fluctuation of the crop averages, the growing of plants corresponding to the optimum of the given natural conditions is more appropriate.

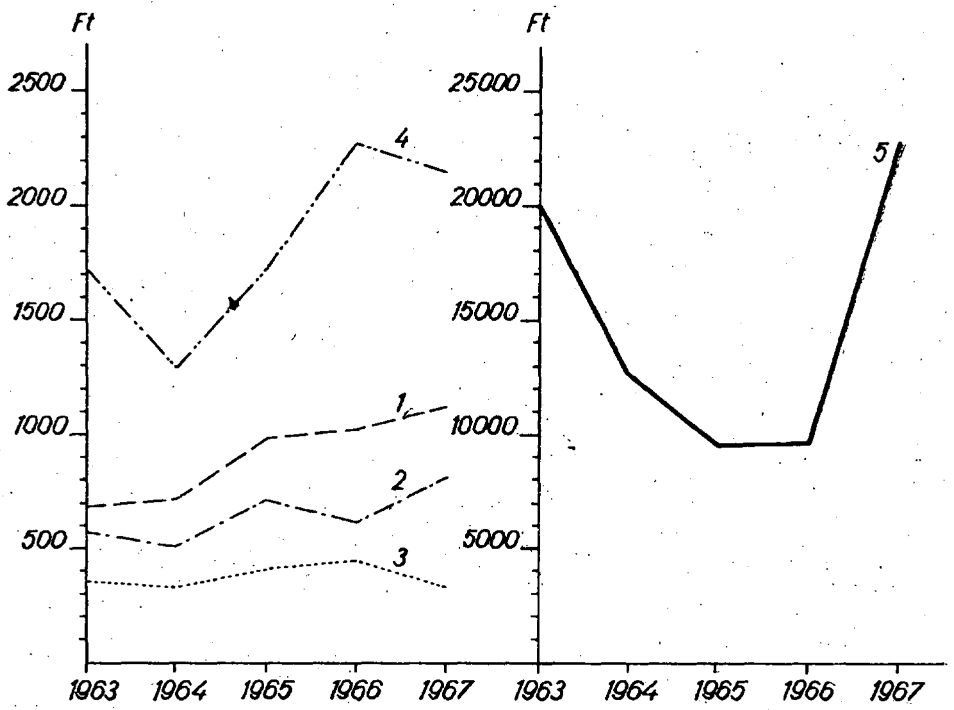

Fig. 8. Trend in the income per 1 cad. hold in Medgyesegyháza. 1 = wheat, 2 = barley, 3 = maize, 4 = sugarbeet. 5 = groundnut.

(Here also must be noted that the financial system, which on the 1st January 1968 entered into vigour, = has raised the agricultural price-level and with the system of assisting the income regulating system of cooperative farms influences the resulting incomes considerably, in the income formations however the demonstrated tendency comes into effect.

Examining the rentability of production, as an additional material may serve also, if the groundnut is compared with sunflower, an oil-containing plant grown in Hungary under optimum climatic endowments. The growing of sunflower is similarly more extensive and its production cost in 1965 was 404 Ft/q on the average of all cooperative farms (E. CSIZMADIA—L. DANKOVITS—L. UDVARI, 1968). The fact that either the oil content of the shelled sunflower seed (45 to 55 per cent) remains behind the groundnut argues likewise in favour of sunflower growing.

The annual 1000 t requirement of the Hungarian oil industry could not be satisfied economically by our groundnut growing. It is more advantageous to import groundnut oil from abroad for this purpose or replace it by growing other plants respectively.

The examination of import possibilities belongs to the rentability calculations. The price of imported raw-seed-coated groundnut between 1962—1967 was 2700 Ft/q, while between 1967—69 Ft 2062 per q. (At the lower price also 100 tons groundnut of Vietnam provenience were imported in the past years but also its quality was inferior). (In the last two years the import price was formed with 60,06 Ft foreign exchange multiplier, taking 10 per cent customs duty, the inland freight charges and 11 to 12 per cent roasting loss in consideration. Seeds of imported groundnut have 8 per cent water and 47 to 48 per cent oil content. The extracted grits contain about 47 per cent crude protein.

Comparing the 2700 and 2062 Ft import price respectively with the buying up price of about 3500—3800 Ft in the last years at national economy level the growing of groundnut in Hungary is uneconomical. The risk in smaller on household areas, it is comprehensible therefore that the population which has experiences in the production is dealing with groundnut growing on smaller areas even today.

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A FEW PROBLEMS OF THE PRODUCTION AND CONSUMPTION OF COW'S MILK IN COUNTY CSONGRÁD

MRS. ABONYI, DR. JOLÁN PALOTÁS

Milk plays an exceptionally important role in the nutrition of mankind as it contains large quantities of amino-acids indispensable for the organism, well supplementing the vegetable proteins by this. Many calcium compounds and phosphoric acid salts are contained in it, whereby the protein utilization is facilitated. Its fat is rich in vitamins-A and F. Notwithstanding all these qualities the milk is one of our cheapest nutriments, the nutritive value of 1 liter milk being equivalent to that of e. g. 8 eggs, 45 dkg lean meat or 2,5 kg vegetables. Milk is the most important food-stuff of public supply, still our country occupies a very unfavourable position in the milk- and dairy product consumption on the ranklist of European countries. (Among the European countries only the populations of Portugal and Spain consume less milk and milk production than the ours.)

Undoubtedly a substantial progress is evident in the last period but neither the actual results can be called reassuring. (A considerable consumption increasing effect was achieved by a few central dispositions issued recently, but also further on important tasks remain incumbent upon the

a) milk industry,
b) trade and
c) agriculture.

a) Our milk industry has done lately much for the expansion of the milk- and dairy product consumption as large scale as possible. In this field the assortment-enlargement is to be stressed first of all but the disposition has likewise a consumption increasing effect that the shops can send back return-goods to their centre within the guaranteed time, without price sanctions. The tendency is good but with a steady commodity supply and a broad scale of good quality dairy products, the industry can give a positive impact to the dairy product consumption of our population also further on. The co-operative farms help the supply with the local manufacturing of dairy products.

b) Much remains to be improved in the field of building-up the network of trade. In national relation still in 1969 213 communities (against 642 of the preceding year) did not benefit from an organized milk-supply). Jointly with a more perfectioned building-up of the network of milk-industry, the number of specialist, milk-industry shops must be increased.

e) An important task devolves however on the agriculture as well. In the first place a rise of the milking average will have to be attained by means of a good breed composition, judicious and economical feeding and by bringing about a healthy environment. The numerical reduction of the cattle-stock must be likewise stopped.

Unfortunately also our County is characterized by a periodical decrease of the cattle-stock (and within it of the cow-stock) (wave-trough in 1961 and 1968). This tendency is the most intensive in household farms but the cow-stock of State Farms is stagnant similarly or proceeds in a slightly decreasing direction respectfully. (Fig. 1.) A growing tendency

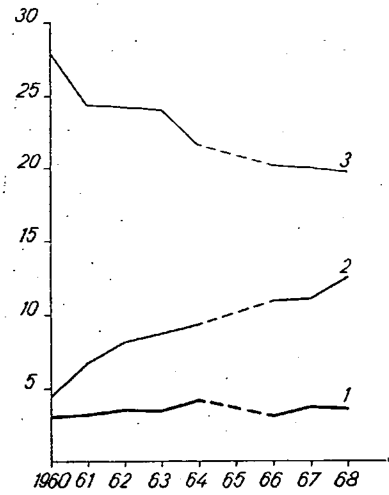

Fig. 1. Trend in the cow-stock per sector in County Csongrád (in 1000 heads)
1 = State Farms
2 = Cooperative farms
3 = Cooperative Farms household and individual.

can be observed in the cooperative farms but either they can counterweight the regression of the other two sectors. The average yearly milk-yield of the existing cow-stock changes barely during the 1960—1968 period, apart from a minor wavetrough of 1961—1962, thus the problem caused by the numerical reduction is not solved by a rise of yield. Having in view that both the internal supply and the increasing export-requirement demand an ever larger performance from our animal-breeding, we must find the incentives which shall be instrumental to stop this stock decrease. For the time being we are not in possession of the material precondition to run-in the milk-producing activity of collective farms in such a way that they should become capable to substitute the household farms. (The most important problem is the shortage of modern barns).

The milk production of County Csongrád in 1968 was 938 100 hl which was divided by sectors as follows:

Sector	Produced milk (hl)	In percentage of the total
State Farm	112 400	12,0
Cooperative farms	337 700	36,0
Coop. farm groups	2 300	0,2
Household farms	485 700	51,8
Totally	938 100	100,0

The above data demonstrate that in 1968 still the household farms gave a considerable part (51 per cent) of the produced milk. The tendency of the milk production during the last 10 years reflects the same situation as the distribution of the cow stock. The decrease of the cooperative farm, household and individual share in the total quantity of produced milk is in favour of the cooperative farms in the first place and of the State Farms in a smaller degree.

Examining the trend of milk production in the past 9 years it can be established that a smaller regression occurred in 1961, while a heavier in 1964/65. The decrease in the production of 1961 did not involve also a reduction in the quantity of the bought-up milk (Fig. 2.) but the decline

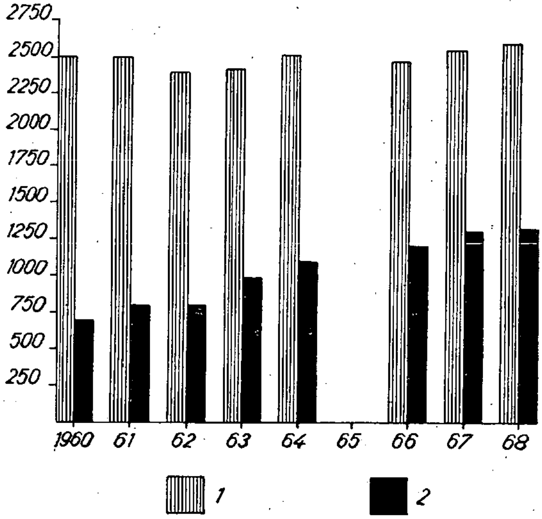

Fig. 2. Trend in the quantities of produced and bought-up milk in County Csongrád = in million litres)
1 = produced milk
2 = brought-up milk

occurred in 1964—1965 is considerable (represented an about 5000 hl shortage in the buying-up). The quantitative reduction of the milk-yield was caused by the foot-and-mouth disease which affected 36 per cent of the cattle stock. The 1964 level of milk production was attained again by the County in 1967 only. Since the wave-trough of 1965 the tendency is a rising one to such an extent that it was not broken either by the milder epidemic of the foot-and-mouth disease reappearing in 1968/69.

The per capita milk production of the County was 209 liters in 1968 which in the order of succession of counties corresponds to.....

As the population of our county does not consume the total milk-quantity produced, the surplus is transported to Budapest in the first place in form of loose milk, but a contribution is given also to the milk-supply of the border region of Bács-Kiskun and Békés counties. Among the exports of our dairy products only the butter is worth mentioning (382.700 kg in 1968).

In comparing the 1968 cow-stock of County Csongrád with that of 1960 it is conspicuous that apart from the smaller wave-troughs it is stagnant during the nine above mentioned years. In the field of milk-production per cow however a slight improvement is present. While in 1960 the County average was 2510 liters, it rose to 2594 liters by 1968. Regrettably this quantity can still not yet be called satisfactory and the most important task of our animal breeding is to produce some improvement in this field.

It is interesting to have a look at the trend in the milk-yield per cow and per sector:

Sector	Year 1960	Year 1968
State farms	3622 litres	2932 litres
Cooperative farms	2457 litres	2689 litres
Household and individual farms:	2410 litres	2469 litres

(on the ground of animal census in the spring)

While in 1960 in the State Farms 3622 litre was the milking average, it decreased to 2932 lit. by 1968/in consequence of a thinning of the cow-stock.

While in 1960 the milk-yield per cow in State Farms was 1212 litres higher than in households of the cooperative farms and in the individual household farms, this milk-yield difference diminished to 463 litres by 1968. The twice occurring foot-and-mouth disease which precisely in the State Farms was the most severe (where the largest number of animals was accomodated in each establishment) has contributed to this in a large measure.

(The environment and feeding, jointly with the selection of breed, display the largest influence on the formation of milk yields. The analysis of this domain of problems merits however an independent study.)

It is fortunate that the quantity of purchased milk — apart from the regression in 1964/65 — is uniformly speeding up. (Fig. 3.) A positive fact is similarly that the monthly fluctuation of buying-up is not too intense. Taking the February minimum as 100 for a basis, the maximum in August is 135. The quantity of milk bought-up during the intermediate months fluctuates between these extreme values — causing relatively not much problems to the milk industry. (Page 6.)

The milk and dairy products consumption per capita of the County Csongrád, converted to milk, was 11 litres higher in 1967 than the national average. (The national average was 145, that of the County 156 central position through this. because the smallest per capita consumption central position thorugh this, because the smallest per capita consumption per county was 113, the highest 187. Though these values present a relatively high variation, still all these figures can be called as low.

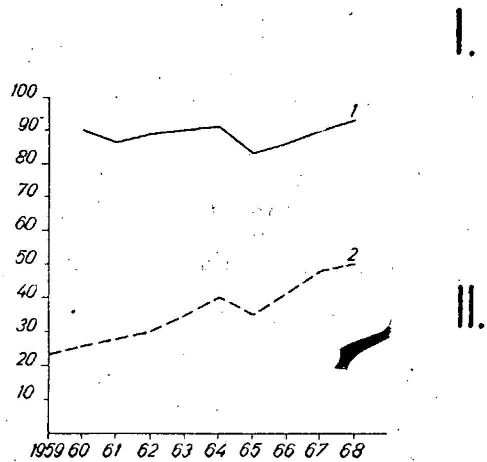

Fig. 3. Trends in the milk-yields and milk buying-up per cow.
== average milk quantity given by one cow
= bought-up milk quantity per cow.

According to data of the Institute for Food- and Nutrition Science 260 liters represent the optimum milk consumption level in our country.

Month	Quantity of the bought-up milk in liters	Buying-up in February =100
January	37 593	104
February	35 794	100
March	38 159	106
April	38 178	106
May	43 792	122
June	44 707	124
July	46 625	130
August	48 483	135
September	45 115	126
October	43 438	121
November	37 297	104
December	40 046	111

This value depends upon countries, climate, composition of the population according to age, structure of its food-stuffs, traditions etc., therefore is far higher here and there. The consumption by the population of County Csongrád lags still considerably behind this figure. It would not be possible either to satisfy the population with so much milk with the present cow-stock, but this „ideal" quantity of milk consumption is even not yet claimed for the time being. Conditions for the expansion of milk consumption are to make the population conscious of the biologically important role of the milk on the one hand and rearing of a healthy, well milking cow-stock, hygienic milk production, modern milk-manipulation and transport, as well as hygienic selling methods on the other. The regular milk and cacao supply of schools must be put in practice. Steps shall be taken to keep abreast with the employment of up-to-date packing methods with plastic materials and paper, furthermore sterile milk should be put into circulation which may be preserved over 20—30 days also.

The growing tendency of milk- and dairy products consumption may be called positive. The consumption of nutriments rich in protein is at the same a yardstick of the qualitative level of nutrition as well. It is a world-phenomenon that the rate of consumption of the various dairy products increases at the expense of liquid milk. The Food-Science Institutes suggest about one third of consumption in liquid milk and two-thirds in the form of dairy products. The population of our country consumes more milk, than dairy products converted to milk. (In case of larger consumers the ratio is displaced in favour of the dairy products). This appears also in the consumption of the town of Szeged, the structure of which is as follows.

Milk and dairy products	Absolute quantity of consumption, hl, q.	Consumption per capita, lit. kg.
Consumption milk, totally	110 047	91 705
Flavoured products	1 563	1 302
Sour milk products	702	0,585
Clotted cream	2 763	2,302
Sweet cream	510	0,425
Butter	2 872	2,393
Hard cheese	233	0,194
Semi-hard cheese	1 323	1,103
Soft cheese	64	0,053
Mouldy cheese	92	0,076
Cream-cheese of sweet cream	8	0,006
Processed cheese, in block	898	0,749
Processed cheese in cardboard boxes	1 124	0,937
Cheeses totally	3 753	3 127
Table curd	1 280	1 067
Flavoured curd	21	0,017

According to the above table the consumption of table may be regarded as particularly low, amounting to 1067 kg only, per capita and year. Furthermore the consumption of sour milk-products is infinitesimal (0.585 kg) and spreading of these is just now in course. The low state of our butter consumption is correlated with our specific dietary form.

Summary

The consumption of milk and dairy products in our country can be called exceptionally low. (It is higher everywhere in Europe, two countries excepted.) Though in national relation — as regards consumption — the County Csongrád does not occupy the last place, but is still at a far lower level (156 litres) than it could be considered satisfactory.

The cow stock of our County has shown a mildly decreasing tendency during the period from 1960 to 1968. (The regression of the cow stock in household farms is responsible for this which could not be counterbalanced by the socialist sectors.) Since neither the milking average rose in the above period a substantial quantitative change did not occur either in milk production. It is fortunate however that the buying-up, as well as the demand and consumption of the population have likewise grown. As our internal consumption and export requirements increased similarly — against which the quantity of produced milk has barely changed — our surplus which was contributing to the supply of other counties and of Budapest has diminished. This tension subsists and representing a national phenomenon is by all means worthy of attention, and all efforst must be done to stop the reduction of cow stocks, and to raise the milking average. Parallel to this — and notwithstanding the diminution of the surplus — a further influence is to be exerted in the direction that quantitative and qualitative demands of our population for milk and dairy products be intensified and their alimentation be displaced toward a healthier direction.

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THE VAPOR CONTENT OF THE AIR LAYERS NEAR THE SOIL OF SANDY WOODED STEPPES IN FALL

BY J. JUHÁSZ

Besides the radiation system and the air flow the active surfaces, such as the crown level, the brush level, the surface of the bare soil, etc., play an important role in the development of the local peculiarities of temperature and air humidity (1).

The daily amplitude of temperature is usually greater in the valleys or depressions than in the plains, on the slopes and summits; in the daytime the summits, elevations, hill-tops do not warm up as much as the lowlying parts, they give off more heat to the air masses, and at night they do not cool off as much because the cold air flows down (2).

In summer and spring the daily amplitude of temperature was much smaller on the sandhill tops than on the steppe-meadow, the sedge meadow and in the spaces between sandhills owing to the rise of the temperature minima and the decrease of the maxima. In connection with the fall measurements we found that the nocturnal cooling of the air layers near the soil-depending on the density of vegetation and through heat conduction-developed in a much more complicated way than the warming (3).

We have mentioned the well-known importance of water in connection with soil and atmosphere as well as the variability of the vapor content of the local air layers near the soil depending on the compactness of the plant associations, radiation, and air flow. Generally the areas, depending on the situation of the basic landscape units and the compactness of the plant associations, are subject to variations in the vapor content of the local air layers near the soil. The air layers of the areas near the soil are ofter subject to violent temperature variations, and with the occurence of these phenomena the saturation valves become modified (1).

In the function of the air temperatures we determined on the basis of Aujesky s theory the variations of the saturation values. Also, being in possession of the saturation and relative humidity values, we determined the values of absolute vapor content and saturation deficiency in the various areas (1).

In the course of complex territorial examination of the geographical small landscape there is an opportunity for comparison or *evaluation of the vapor content by basic landscape units.*

According to practice used so far also we employed here the method of *comparative* and *principal factors* (4).

Our aim was to find out on the basis of the results *what are the characteristics of the vapor content in fall* within the different plant associations under known soil and air temperature conditions.

On the basis of the saturation values we have referred, within the —5 to 10° temperature range, to the average rise. We have demonstrated that a more considerable increase in the saturation values can be observed only in the case of more considerable warming, above 20°. At the same time we have referred to the percentage rise per 1° of the saturation values between —0 and 40° within 10° ranges— (1).

For the determination of the absolute vapor content and the saturation deficiency as well as of the corresponding slopes of the extreme values of relative humidity we as a function of time present the daily extreme values of the relative vapor contents developed in two levels over the soil surface (Table 1).

Table 1.

f The daily extreme values of the relative vapor contens (November 1962, Csévharaszt)

	Height over soil cm	max. %	2 nd min. %	max. %	3 rd min. %	4 th max. %
Sandhill top	10	100	73	100	66	100
	150	100	78	100	68	97
Space between sandhills	10	100	70	100	66	96
	150	100	76	100	71	100
Steppe-meadow	10	97	73	100	69	95
	150	97	74	97	68	97
Quercus robur stand	10	97	77	99	71	87
	150	100	74	100	66	97
Juniper brushwood with poplars	10	98	79	100	77	97
	150	99	74	100	69	97
Sedge-meadow	10	100	78	100	73	98
	150	98	72	97	64	99
Oakwood with lilies of the valley	10	97	85	99	73	100
	150	98	73	96	65	97
Poplar grove	10	100	84	100	79	96
	150	99	73	97	67	95

At the time of the development of the relative extreme values presented there was generally cloudy, rainy weather in Central Europe. On the finst the lingering front of the cyclone that developed divided the territory of our country into two parts: the weather was rainy, cold and windy in Transdanubia, while in the eastern half of the country it was mild. On November 2, great storms and rains formed with the collapse of the cyclone. On November 3, the weather in our country was misty, foggy, cloudy. Between the Danube and the Tisza and in the northern counties the clouds broke up in the early morning and for several hours there was sunshine (5).

It appears from the macrosynoptic situation that in the fall of 1962, the period of observation, cool rainy, foggy weather prevailed in the area examined.

It was in the midst of these conditions that the values of the soil temperature and of the temperature near the soil as well as the relative humidity developed. We determined the saturation values as well as the absolute vapor content and the saturation deficiency. In such and similar conditions the temperature (T), the saturation value (A), the relative humidity (R), the absolute vapor content (a), and the saturation deficiency (S) can be examined together complexly on the basis of Table 2 in the different areas and plant associations.

Table 2.

Characteristics of the air humidity
(November, 1962, Csévharaszt)

Height over soil	At time of maximum relative humidity					At time of minimum relative humidity				
	T	A	R	a	S	T	A	R	a	S
cm	°C	gr/m³	gr/m³	gr/m³	gr/m³	°C	gr/m³	gr/m³	gr/m³	gr/m³
Sandhill top										
on 2										
10	5,7	7,14	100	7,14	—	12,2	10,93	73	7,98	2,95
150	3,9	6,37	100	6,37	—	11,8	10,65	78	8,30	2,35
on 3										
10	4,8	6,72	100	6,72	—	14,6	12,59	66	8,30	4,29
150	4,6	6,65	100	6,65	—	14,2	12,31	68	8,37	3,94
on 4										
10	0,8	5,17	100	5,17	—					
150	1,4	5,39	97	5,22	0,17					
Space between sandhills										
on 2										
10	4,1	6,45	100	6,45	—	14,2	12,31	70	8,61	3,70
150	4,2	6,49	100	6,49	—	12,0	10,79	76	8,20	2,59
on 3										
10	5,0	6,80	100	6,80	—	16,4	14,10	66	9,30	4,80
150	4,9	6,76	100	6,76	—	13,4	11,75	71	8,34	3,41
on 4										
10	0,2	4,90	100	4,90	—					
150	0,6	5,09	100	5,09	—					
Steppe-meadow										
on 2										
10	3,0	6,02	97	5,87	0,18	13,2	11,62	73	8,48	3,14
150	4,3	6,53	97	6,33	0,20	12,4	11,07	74	8,19	2,88
on 3										
10	4,0	6,41	100	6,41	—	13,4	11,76	69	8,11	3,65
150	4,8	6,73	97	6,52	0,21	13,7	11,97	68	8,13	3,84

on 4										
10	1,4	5,39	95	5,12	0,27					
150	2,0	5,63	97	5,46	0,17					
Quercus robur stand										
on 2										
10	3,1	6,06	97	5,87	0,19	12,1	10,86	77	8,36	2,50
150	4,2	6,49	100	6,49	—	12,2	10,93	74	8,08	2,85
on 3										
10	6,8	7,73	99	7,65	0,08	14,7	12,66	71	8,99	3,67
150	4,8	6,93	100	6,93	—	13,7	11,97	66	7,90	4,07
on 4										
10	2,3	5,75	87	5,00	0,75					
150	1,8	5,55	97	5,38	0,17					
Juniper brushwood with poplars										
on 2										
10	5,2	6,90	98	6,76	0,14	11,6	10,52	79	8,13	2,21
150	4,5	6,61	99	6,54	0,07	11,5	10,45	74	7,73	2,72
on 3										
10	7,1	7,89	100	7,89	—	13,4	11,76	77	9,05	2,71
150	4,4	6,57	100	6,57	—	13,7	11,97	69	8,26	3,71
on 4										
10	1,5	5,43	97	5,26	0,17					
150	2,1	5,67	97	5,50	0,17					
Sedge-meadow										
on 2										
10	2,2	5,71	100	5,71	—	13,1	11,55	78	9,01	2,54
150	1,9	5,59	98	5,48	0,11	11,3	10,31	72	7,42	2,89
on 3										
10	3,1	6,06	100	6,06	—	15,3	13,22	73	9,58	3,54
150	5,6	7,11	97	6,89	0,22	13,6	11,90	64	7,61	4,29
on 4										
10	2,0	5,63	98	5,51	0,12					
150	2,1	5,67	99	5,61	0,06					
Oakwood with lilies of the valley										
on 2										
10	7,2	7,94	97	7,70	0,24	11,1	10,17	85	8,64	1,53
150	4,4	6,57	98	6,44	0,13	11,2	10,24	73	7,47	2,77
on 3										
10	4,1	6,45	99	6,38	0,07	14,0	12,17	73	8,88	3,29
150	5,3	6,92	96	6,64	0,28	13,7	11,97	65	7,78	4,19
on 4										
10	1,5	5,43	100	5,43	—					
150	2,3	5,75	97	5,58	0,17					
Poplar grove										
on 2										
10	3,8	6,33	100	6,33	—	10,0	9,41	84	7,90	1,51
150	4,8	6,73	99	6,55	0,18	11,2	10,24	73	7,47	2,77
on 3										
10	5,0	6,80	100	6,80	—	13,2	11,62	79	9,18	2,44
150	4,9	6,76	97	6,56	0,20	13,5	11,83	67	7,93	3,90

on 4

10	1,6	5,47	96	5,25	0,22
150	1,3	5,35	95	5,08	0,27

From the values of the air humidity it can be seen that the saturation values, the relative humidity the absolute vapor content and the saturation deficiency are all functions of the temperature.

The saturation values in heat grow rapidly with the temperature. The saturation deficiency is, in case of the same relative humidity, much greater in heat than in cold (1).

The influence of the situational peculiarities on the heat system could not develop to the same extent as in the areas with greater level differences. The situational peculiarities were influenced partly by differences of the soil, partly by differences of the plant associations and the environment. Some peculiarities, however, remained; for inctance the air layer near the soil of the sandhill top did not warm up or cool off so much as that of the space between sandhills. The air between the sandhills was cool and damp at night and in the early morning, while it was warm and dry in the afternoon; inverses of these phenomens were observed on the sandhill top.

On the basis of the results of the investigation period in the fall of 1962 we have established that the nocturnal cooling of the air layers near the soil, depending on the density of the vegetation and the kinds of plant associations (6) by heat conduction, developed in a much more complicated way than the warming up.

The influence of dynamic convection and advection was most noticeable in the open areas, as on the steppemeadow and the sedge-meadow, in the daytime but with significant differences in the various basic landscape units (7).

The temperature of the soils on the steppe-meadow, in the space between sandhills, and on the sedge-meadow influenced the temperature of the air layers near the soil more in the day than at night (Fig. 1).

The turbulent effect of the air flow sometimes produced absurd results in the air temperature. The daily temperature wave varied in the afore-mentioned open areas (3) in the different basic landscape units. The active surfaces in the juniper brushwood with poplars and the oakwood with lilies of the valley became active controllers of the temperature and humidity of the air layers near the soil (Figs. 2 and 3).

Besides the radiation system and the active surfaces the air flow has always an important influence on the temperature of the air layers near the soil, indirectly on air humidity, and so plays an important part in the development of the local peculiarities.

The horizontal air flow over the soil surface is weakened owing to friction and eddying. The weakening of the process is determined by turbulent exchange as a result of the unevenness of the soil surface and the vegetation cover on it. The turbulence is intensified by the height of the plant associations in the half-closed and closed areas in the different basic landscape units (facies) and even in the different landscape mosaics (urochishche), and in the open areas by the unevenness of the soil surface

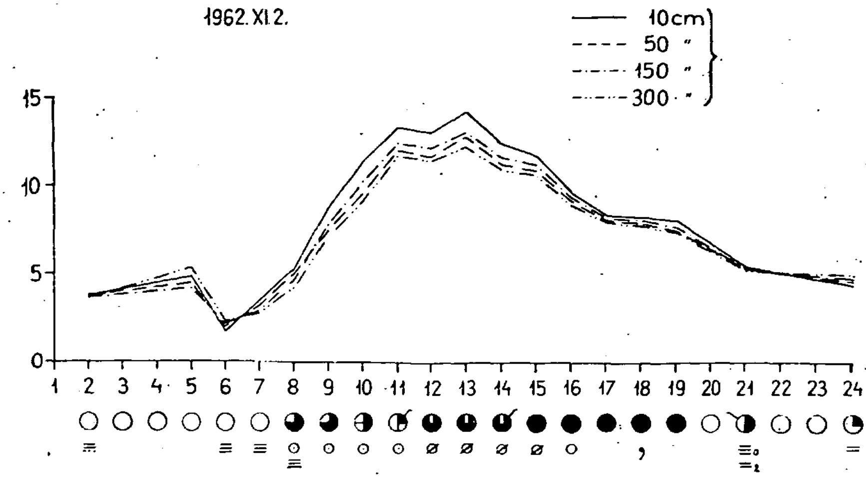

Fig. 1. The diurnal variation of the air temperature on the steppe-meadow.

(3). These factors always played a part in the varied development of the relative humidity, the absolute vapor content, and the saturation deficiency (Table 2).

Owing to weak radiation conditions the temperature of the air layers near the soil cooled off on November 2 and 3, 1962. The mixing effect of the air flow caused temperature variations in the warming of the air layers near the soil in the daytime. The frequent temperature variations influenced the development of the saturation values (7), or more exactly, changed the saturation values the natural consequence of which was the varied development of the „R", „a" and „S" values.

We found that the values of air humidity are always primarily conditioned by the temperature. The daily variations of temperature can be expressed by the values of the slopes. Since we have to reckon with factors or variables connected with the temperature, the diurnal variation of the *relative humidity,* corresponding to the periods of warming and cooling, can also be expressed by *slopes.* The difference is only that to the positive direction tangent „T" in relation to „R" correspods a negative direction tangent, or vice versa. In our measurements and in similar cases where such correlations can be demonstrated *the extreme values can* always *serve as the basis of the calculations.* The changes of temperature or air humidity between the extreme values can be interpeted as *the ranges of the values expressed by the slopes.*

The temperature differences between x the air layers over the soil surface at the same time can be expressed by the function $f(x) = \text{const.}\ a^{x-}$ both in the period of warming and cooling. This method can be employed to demonstrate the temperature differences between the soil layers as well as to compare the changes in air humidity, for instance in relative humidity.

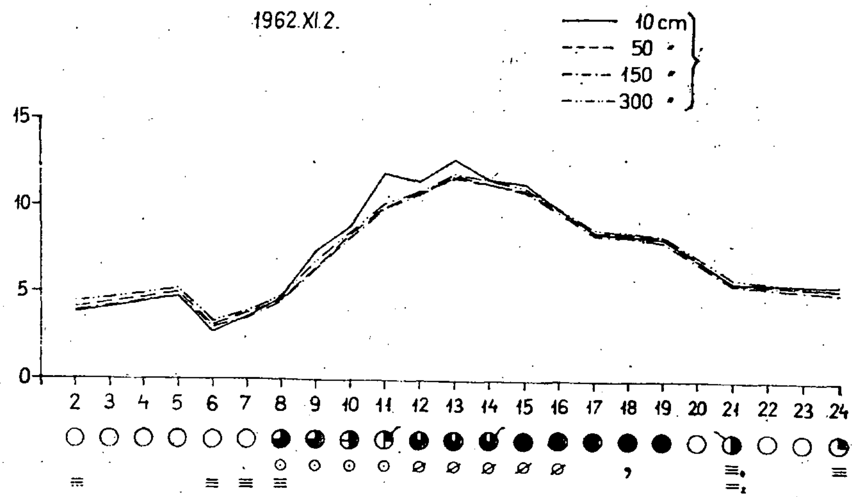

Fig. 2. The diurnal variation of the air temperature in the juniper bruswood with poplars.

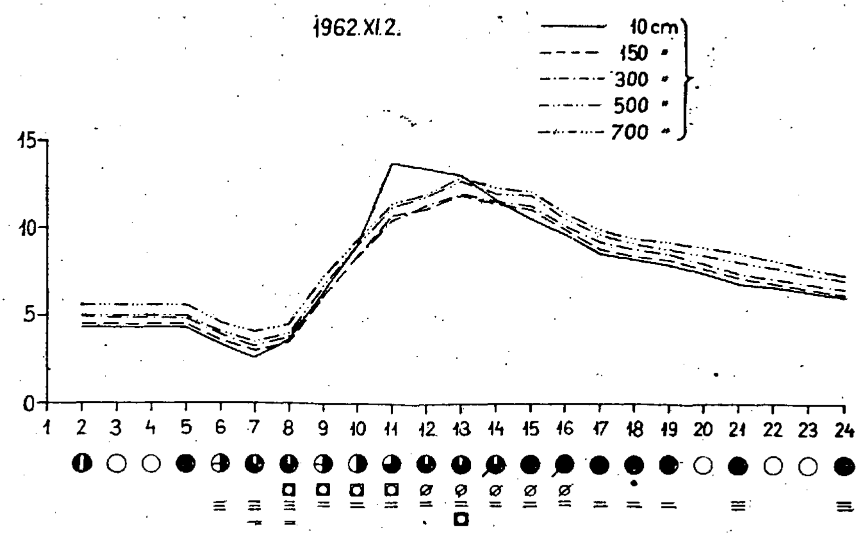

Fig. 3. The diurnal variation of the air temperature in the oakwood with lilies of the valley.

If the temperature of the air layers and soil layers or the relative humidity are examined in daily intervals, the gradient can be determined, besides the methods already known, by the aid of the extreme values of the factor to be examined:

$$m = \frac{y_2 - y_1}{x_2 - x_1}.$$

The slopes can be determined with the coordinates of the extreme values of the factors to be examined. In case of cooling the angle of the gradient is for instance negative as regards air temperature and soil temperature while in case of warming it is positive. In case of such an examination of the relative humidity we must reckon with the inverses of the results found in the temperature values.

The magnitude of the diurnal changes in temperature and relative humidity can be read from the gradients of the slopes. Using the above method we determined for each area and layer the slopes of the air temperature and relative humidity values as of correlated factore (Table 3). Here T denotes the slope of the temperature-difference as curve of a function of tune in degrees provided that 10 °C is represented by the same length as 6 hour.

R denotes the slope of the curve of relative humidity as a function time in degrees provided that 10% relative humidity is represented by the same length as 6 hour.

Table 3.

Slopes of air temperature and relative humidity values

Height over soil		In period of warming		In period of cooling	
		T	R	T	R
	cm	degree, hour	percentys hour	degree hour	percentys hour
Sandhill top					
on 2	10	57,5	−81,6	−31,8	58,0
	150	54,8	−77,1	−30,6	50,2
on 3	10	63,1	−75,7	−50,7	65,6
	150	60,3	−75,9	−41,0	61,0
Space between sandhills					
on 2	10	63,0	−80,6	−34,2	60,4
	150	58,6	−75,0	−32,2	71,6
on 3	10	64,0	−78,3	−55,6	64,9
	150	61,3	−71,0	−58,0	69,0
Steppe-meadow					
on 2	10	60,7	−75,0	−34,2	62,5
	150	57,0	−73,0	−27,1	56,8
on 3	10	61,1	−77,2	−53,1	67,0
	150	48,8	−71,0	−54,5	69,2
Quercus robur stand					
on 2	10	52,6	−63,5	−26,6	67,7
	150	47,0	−83,4	−26,1	55,4
on 3	10	57,5	−77,8	−54,1	74,9
	150	43,3	−73,7	−49,7	79,0
Juniper brushwood with poplars					
on 2	10	46,4	−72,4	−25,2	47,8
	150	51,2	−74,4	−26,1	65,2
on 3	10	52,7	−80,1	−43,5	65,7
	150	53,9	−68,8	−41,1	66,8

Sedge — meadow					
on 2	10	66,0	−82,9	−43,9	72,4
	150	58,0	−79,2	−36,5	72,2
on 3	10	73,2	−75,9	−61,7	83,7
	150	50,0	−79,7	−53,5	84,8
Poplar rove					
on 2	10	53,1	−76,0	−20,9	68,2
	150	56,8	−80,5	−27,1	73,7
on 3	10	49,5	−66,8	−49,8	81,9
	150	56,8	−73,5	−45,1	81,8

The slopes of the temperature corresponding both to 10 cm and 150 cm heights in the period of warming were on average smaller on the 2 nd than in the same period on the 3 rd.

The slopes of the temperature, corresponding to 10 cm and 150 cm height, respectively, were in average the month than in the same period on the 3 rd.

In 10 cm height over the soil surface the *shade effect,* in 150 cm height advection slowed down the rate of warming in spite of the fact that the radiation conditions improved considerably (on the 2 the nd sunshine period was 3,2 hours, on the 3 rd it rose to 5,9 hours). With the exception of the air temperatures measured in 150 cm on the steppe-meadow, in the Quercus robur stand, and on the sedge-meadow where the rate of warming was slow, the warming of the air became faster at both levels in the area of all the basic lanscape units on the 3 rd in spite of the fact that the rain of the previous day had cooled off the surface of the areas examined. The incoming quantities of energy ensured faster warming of the soil and of the contiguous air layers and the evaporation of its water content (3).

On the basis of a complex examination of the air humidity values (Table 2) we established that the absolute vapor content was in the early morning hours on average 1—3 gr/m^3 less than in the midday hours when the temperature varied around the maximum and the relative humidity around the minimum. This determination applied to areas of the sandhill top, the steppe-meadow and the sedge-meadow, to all three landscape mosaics, and to the half-closed and closed areas.

The saturation values (A) increased or decreased in each basic landscape unit parallelly with the temperature (T). A consequence of the above-described development of the two correlated factors is that in case of similar relative humidities (R) the saturation deficiency (S) was alway greater in heat than in cold.

The differences between the values of absolute vapor content (a) were minimal not exceeding 1—2 gr. The relative humidity varied generally between 95—100. A value of 87% was observed in 10 cm over the ground in the Quercus robur stand on the fourt of the month. Thus the basic landscape unit (facies) where the saturation deficiency was greatest (0,75 gr/m^3) was determined. During the period of observation the air was saturated in both heights on the sandhill top and in the space between sandhills.

In the midday hours during the period of observation the air near the soil warmed up on the sandhill, in the space between the sandhills, on the steppe-meadow and on the sedge-meadow, in the open areas more intensively than in the closed areas. Corresponding to the warming rose the saturation value in the different areas, while there was hardly any change in the absolute vapor content (Table 2).

In the open areas — in basic landscape units — the saturation deficiency varied between 2,35 and 4,8 gr/m^3; in the half-closed areas between 2,21 and 3,71 gr/m^3. In the closed areas in places further decrease in the saturation deficiency was observable. Only the saturation deficiencies of the oakwood with lilies of the valley and the juniper brushwood with poplars constitute an exception.

In general in the fall period of observation the heat used for evaporation, the humidity of the soil, the evaporating surface of the vegetation, and not the least the radiation, decreased considerably. On the other hand *these factors* working together invariably *control evaporation.*

For consideration we present here the slopes relating to the near-to-soil temperature and relative humidity of the forest climate (Table 4).

Table 4.

Diurnal Slopes of the air temperature and relative humidity of the forest climate

	Height over soil cm	In period of warming T degree hour	R percents hour	In period of cooling T degree hour	R percents hour
on 2	200	45,0	−48,8	−20,4	50,9
on 3	200	48,8	−75,5	−34,7	57,5

Abbreviations: T = temperature, A = saturation value, a = absolute vapor content, R = relative humidity, S = saturation deficiency.

Evaluating the slopes of the forest climate and the basic landscape units we could see the following facts:

The absolute values of the slopes of the air temperatures are generally greater in the period of warming than in the period of cooling. This is also true of the relative humidity.

Under conditons of weak radiation there are in both periods greater differences between the absolute values of the slopes of the temperature in the different basic landscape units than under condicions of intense radiation. This rule is also valid for the relative humidity.

As for air temperature and relative humidity, differences between the slopes in open basic landscape units are much smaller than in half-closed or closed basic landscape units.

Our rules concerning the temperature, relative humidity and other properties of air humidity contributed to a better differenciation of the basic landscape units.

For the differenciation of the basic landscape units of the landscape mosaics the evaluated air humidity values as chief characteristic factors besides the air temperature and soil temperature values (7) are adequate when we use the method of comparative or principal factors.

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SOIL AMELIORATION AND THE MAIN CLIMATIC FACTORS

BY M. DZUBAY, J. JUHÁSZ

Soil amelioration is more than the usual agrotechnical procedures; it is a complex of operations by the effect of which the fertility of soils with unfavorable properties increases lastingly (Fekete et al, 1967). Such operations are for instance reduction of the strong acidity of forest soils by liming, loosening of the compactness of meadow clays with subsoil loosener, and the green manuring of sands.

We can distinguish — in the order of the above-mentioned examples — chemical, physical and biological soil amelioration.

We can think of amelioration also as an artificial interference with the process of soil formation, that is as of another soil-forming factor of human activity.

It is known that there are six main groups of soil-forming factors: geological, relief, vegetation and animal, climate, and human activity.

Here we deal only with the correlation of the last two factors, i. e. some of the more important relations between human activity — chemical and physical soil amelioration — and the climate.

The above-mentioned factors are not always and not is equal measure important in the forming of the different types of soil.

There are cases when a factor belonging to one of these groups becomes predominant and then it rules alone. In other cases a group of several soil-forming factors determines the true character of the soil.

The climate, as one of the soil-forming factors, may facilitate the division of larger areas into smaller parts by various methods. Then we can deal complexly and separately with the different soil-forming factors according to the landscape units determined in this way.

The basic landscape units are characterized by the same lithogenic composition, humidity conditions, microclimate, soil types, and a definite biocenosis. The vegetation, climatic factors, and differences of the soil may serve as criteria for their further division.

The division into landscapes cannot be substituted by climatic, soil geographical, or geobotanical division into districts because it is based on an all-round investigation of the common processes of physical geography.

Berg establishes various fundamental principles and methods for the differentiation of basic landscape units, landscape mosaics, and small landscapes (Juhász, 1968).

According to modern complex investigations — with special regard to soil amelioration — the conditions are more favorable when our rules refer to larger areas and our results are valid for those too.

The effect of the climate on the formation of the soil and on the soil itself is double; direct and indirect.

Direct effects are, for instance, the weathering, eroding, evaporating influences of atmospheric factors. An indirect effect is, for instance, the influence of the atmosphere exerted through the biosphere because directly or indirectly the whole living word takes part in it. Therefore it is important to know to what extent the climate is suitable for the life of plants, animals, microorganisms and humans.

On the inhabited lands we must consider the role of civilized man, the most important factor in soil formation because he is able to exchange the original vegetation and fauna and to change the properties of the soil radically by tilling and amelioration.

The ecological factors of the environment must be examined, in general, in each area on the basis of the same principles because the factors are connected in such a way that changing of any one of them results in changing of the others. The changes in light (weakening or intensification), the air and soil temperature, the soil and air humidity, result in changes in the microbiological processes in the soil.

Among the ecological factors such as the climatic, soil climatological, topographical, botanical and antropogenic factors, the climatic factors must be mentioned particularly.

It is an established fact that the soil conditions are determined by the climate to a considerable extent. The atmospheric factors penetrate into the soil and determine the development of the soil climate. This penetration is mutual because part of the light is reflected, heat is produced and evaporation takes place.

Chemical amelioration is the artifical interference in the life of the soil when the balance of the exchangeable (adsorbed) cations of the soil is shifted with the help of hydrolyzing substances in a direction favorable for cultivation.

This may happen in order to develop a better structure, to change the chemical effect (pH), to ensure the supply of nutrients, or for other purposes. In this case for instance we replace the property-determining H or Na ions with Ca ions in the adsorption complex of the soil.

The adsorption complex consists of clayey mineral and organic humus part. The former may be thought of as a giant molecule with amphoteric character which is a grating layer formed from a polyaluminium hydroxide plane network connected with a polysilicic acid plane network by separation of water. At the edges of the grating layer — owing to the discontinuty — negative SiO and positive Al ions or SiOH and AlOH electrically active radicals appear.

Again, the humus particles may also be thought of as amphoteric giant molecules containing hydroxil, on their surface, carboxil, amide and amino radicals or negatively or positively charged ions.

On the surface of the two constituents (clay mineral) and humus or soil particles the negatively charged are capable of cation adsorption or uptake of protons, the positively charged ions are capable of adsorption of anions or binding the hydroxil ions.

The number of the places suitable for the occurrence of the above-mentioned chemical reactions on the soil particle depends on the composition of the solvate layer which covers it and belongs to it. The quality of the solvate layer is a function of the composition of the soil solution.

On the basis of the above the cation adsorption or cation exchange occurs in the following way: the cation predominating in the system (solvate layer and soil solution), for instance Ca^{++}, which is in the soil solution, changes place with the other cation adsorbed in the solvate layer (for instance with Na^{+} or H^{+}). The reaction is reversible in consequence of which a state of dynamic equilibrium (between the solvate layer and the soil solution) sets in where the number of exchange cations entering the solvate layer from the soil solution or leaving the solvate layer for the soil solution per second is the same (Di Gleria et al., 1957).

This process, i. e. soil amelioration, like chemical reaction in general takes place only in certain media. Since here we are dealing with hydrolyzing substances, the medium is precipitation, rain water, molten snow and subsoil water. The amount of the latter in the soil depends to a great extent in the first on the climate, the macroclimate. In the second place it depends on the microclimate, the quality of the soil its covering, evaporation, etc.

The macroclimate is given; it can be influenced only to a small extent. Therefore we deal with it only little.

The more important climatic factors that influence soil formation and the development of different types of climate are the following: (a) precipitation and the vapor content of the air, (b) winds and air pressure, (c) radiation and heat (Sigmond, 1934).

(a) The amount of precipitation and the vapor content of the air are factors that not only determine the decisive character of the climate but have also the greatest influence on soil formation.

Owing to the capriciousness and the varied territorial and temporal distribution of precipitation in the different small landscapes, landscape mosaics and basic landscape units, a picture of the precipitation conditions, even on a national scale, can only be formed on the basis of observations made by station networks.

Depending on the situation of the areas and the closeness of the plant associations the vapor content of the local air layers near soil is liable to variations. The spaces near the soil often warm up and cool off intensely. Thus a certain amount of proportional correlation between the saturation values can be observed. With combined examination of the air temperature, saturation value and relative humidity the absolute vapor content and the saturation deficiency have been demonstrated in the different basic landscape units (Juhász, 1969).

As we have seen precipitation is the most important factor from the point of view of soil amelioration and realization of the chemical reaction. In this case, too, it is essential in what portions the rain falls on the ground, for it is known that lasting slow rain is the best at the time of growing humidity. Stormy rain usually wets the soil only cursorily and superficially, but a downpour mostly flows away on the surface and causes more damage than advantage. On the other hand, foggy rain may be very substantial from the point of view of wetting.

Another influencing factor as regards the chemical reactions is that the rain (or precipitation) falls in winter or in summer.

Precipitation water is therefore a first-class factor from the point of view of chemical soil amelioration.

In the case of physical amelioration, the situation is different as we shall see, because then the climate or precipitation plays only a secondary indirect role. It promotes chiefly the trans-formation of structure. On the other hand, in the physically ameliorated soil with a lasting structure the climatic factor receives a very important role because it provides the well-ordered water, heat, air balance with an adequate quantity of water, air, and heat.

(b) We are concerned with the air pressure and winds only in as the former is one of the chief causes of the winds and air currents. The winds have a great influence on the humidity conditions of the soil and especially on evaporation and capillary water movement. These again may come into consideration from the point of view of rapid or slow soil amelioration.

(c) Radiation and heat. A large portion of the solar radiation is lost but a small part of it serves as heat energy for warming the lithosphere and the atmosphere, that is for increasing their energy supply.

The radiating energy reaching the surface of the earth warms up the upper soil layers and these transmit the energy partly by conduction to the lower soil layers and the adjacent air layers, partly by eradiation to the upper air layers.

In our country the heat loss of the soil in the afternoon is greater than the heat gain. Thus it is easy to understand that the air is usually hottest not at noon about 2 o' clock in the afternoon. Since the solar radiation decreases more and more in the afternoon and the et from the soil grows at the same time, the soil and the adjacent air gradually cool off till sunrise. After this, irradiation increases till noon. In our country in spring it is the diurnal incoming, in fall the outgoing nocturnal radiation that preponderates. These phenomena influence the chemical, biological and physical processes in the soil both directly and indirectly.

The air of physical soil amelioration is first of all to restore and maintain a good, lasting, crumbly state and ripeness for a long time, in a soil with unfavorable structure the endeavor is, to change favorably the physical properties (such as the water-holding capacity and permeability, aeration, crust formation, and heat balance) of the soil. To achieve this, so far stable manure, green manure, peat, compost, and animal wastes besides chemicals ($CaCO_3$, $CaSO_4$, artificial fertilizers) have been introduced into the soil.

The shortcoming of the methods and materials was that if there is little humus and mineral colloid in the soil, the crumbly structure, which is strongly resistent to irrigation by water and rain, forms with difficulty. (Dzubay, 1967).

Structure formation with the help of perennial grass is also unsuitable because it takes a long time, about the years, and its effect ceases again in 5 or 6 years (Kaufmann et al., 1967).

The above-mentioned classical methods and materials have already solved the problem of amelioration for the most part both theoretically and practically. We feel that in this field only very little progress is possible while for want of knowledge the physical and chemical border surface phenomena cannot, be extended to the polydisperse soil-water-air system of largely heterogeneous composition.

A great practical progress could be made only by having recourse to artifical materials, artifical soil structure stabilizers or soil-conditioning materials. The advantage of these materials over the traditional ones is partly that they do not decompose so rapidly, partly that they can be used in greater concentration. According to Kaufmann and Vogel (1968) they can be divided into (a) polyelectrolytes, (b) artifical material foams and (c) emulsions, and true solutions.

(a) The polyectrolytes are reactive polymers containing active groups (OH^-, $COOH^+$, etc.) and possessing an electric charge. Their effect is that they stick the soil particles together into crumbs with artifical material bridges and the cover them with a filamentary colloid network. The latter protects the crumbs from falling apart and from the silt-forming effect of water. The lasting structure formed in this way ensures a favorable change in the water, heat, and nutrient balance in the soil.

(b) The artificial material foams may be looseners of cellular structure with open (hydrophilic) or closed (hydrophobic) pores. Their primary property is that they exert a chiefly physical influence on the soil. They improve its water, heat, and air balance properties. They bring about a lasting loosening and improvement of the structure and prevent the favorable properties from deteriorating rapidly. The environment so changed, the larger amount of oxygen and the higher temperature, activate the life of the soil and mobilize the nutrients.

(c) The emulsions, true solutions and other materials are materials forming a chemical soil cover or some other shading or a water-impermeable layer under the root zone whose effect chiefly depends on their places of application. On the surface of the soil they mainly reduce evaporation and weediness, while applied at a certain depth they retain the water that has got into the root zone.

The above-mentioned materials are used mainly on sand. Sprayed on the soil surface they form here a film underwhich the temperature is 5—10 °C higher than that of the environment. Thus more favorable life conditions are created for the plants already at the beginning of the vegetation period and if emulsion is introduced into the subsoil, a so called bench is formed which makes retention of the nutrients and the water supply in the root zone as well as their by the plants possible.

It follows from the above that the artificial materials serve above all for physical soil amelioration, for lasting improvement of structure.

In the following we deal with a few procedures that greatly affect the microclimate and thereby soil amelioration and fertility.

These procedures are soil covering with various materials and soil shading with living vegetation. Their practical aim is to turn the radiation, heat, water, and air balance in a favorable direction. For instance extreme warming and cooling of the soil can thus be prevented. These phenomena appear and exert their influence not separately but always in close connection with each other. Change in one factor causes change in the others as well.

One way of changing the heat balance of the soil is influencing the capacity of radiation absorption. This can be achieved by spreading layers of extremely absorptive materials on the surface of the soil. White spreading materials with a high albedo, for instance chalk powder, Buda earth, quartz powder, reduce the capacity of radiation absorption of the soil and consequently its warming. Black materials (soot) have the opposite effect.

According to experiments made with materials of the above-mentioned opposed colors the temperature of the soil in 10 cm depth on a cloudless summer day was 3° warmer with black covering than with white. On the other hand, nocturnal cooling was more intense in the soil with white covering (Di Gleria et al., 1957).

To prove how wrong it is to judge the effect of the artificial alteration of the heat balance properties one-sidedly, we must mention that while black clovering was found to be more favorable for the development of plants with high heat requirement because it increased warming of the soil, flowering took place earlier on the plots with white covering. This phenomenon is due to abundance of radiation artificially produced over the white surface.

According to the experiment the plants with high heat requirement utilized the energy of radiating heat well. We used aluminium sheets painted white which covered 75% of the ground. The white sheets absorbed only half as much of the light and heat energy of the sunshine as the uncovered ground; they reflected and projected the sunshine upon the plants.

Covering changed the warming and the water balance of the soil and air. The covered parts of the ground did not warm up so much as the rest. This effect was measurable to a depth of nearly half a meter.

Owing to less intense warming of the covered surface and reradiation of a large portion of the energy, the temperature over the covered parts in calm was lower use of closeness and less intense warming soil humid under the covered surface remained greater than under the freely evaporating uncovered surface (Bacsó 1966).

The influence of living vegetation on the heat balance of the soil manifests itself not in its capacity of radiation absorption but in its insulating effect which modifies the intensity of incoming radiation. The vegetation equally moderates the intensity of incoming or of outgoing radiation, i. e. it reduces the diurnal and summer warming as well as the nocturnal and winter cooling.

To support this opinion we refer to the paper of Kreybig and Bajai (1952) according to which warming reached 40 °C even in 10 cm depth on a plot with no vegetation, while under carrots the temperature in the same depth was only 30 °C.

A similar insulating effect can be achieved by covering the soil surface with dead organic matter, e. g. straw.

There is an essential difference in the way of the effect of mineral covering material spread in a thin layer and covering with organic matter or living vegetation. While mineral covering changes only the radiation absorption capacity of the soil and has no effect on the intensity of outgoing radiation, the vegetation or organic matter applied in relatively thicker (1—3 cm) layer gives very effective protection against outgoing radiation, i. e. against nocturnal cooling of the soil, too.

Modification of the properties of light by covering influences the heat regime of the soil. This influences also the humidity content of the soil. Any interference that results in reduction of the soil temperature also reduces evaporation, i. e. helps maintain the water supply of the soil (Bacsó, 1966).

On the basis of the above facts we can say that soil covering or shading has an influence on the warming or cooling of the air over the soil surface, i. e. it creates a new microclimate.

Thus soil covering, changing of the albedo, controlling of the sunshine and rational management of controlled heat energy have a definite advantage not only in the cultivation of plants but combined with a favorably modified microclimate also in soil amelioration.

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CONTENTS

Felelős kiadó: Dr. Pénzes István
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